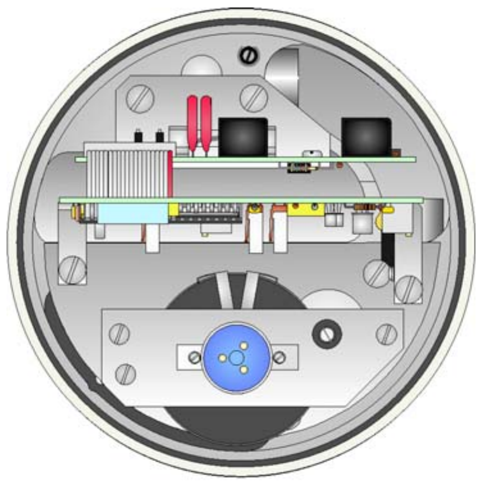
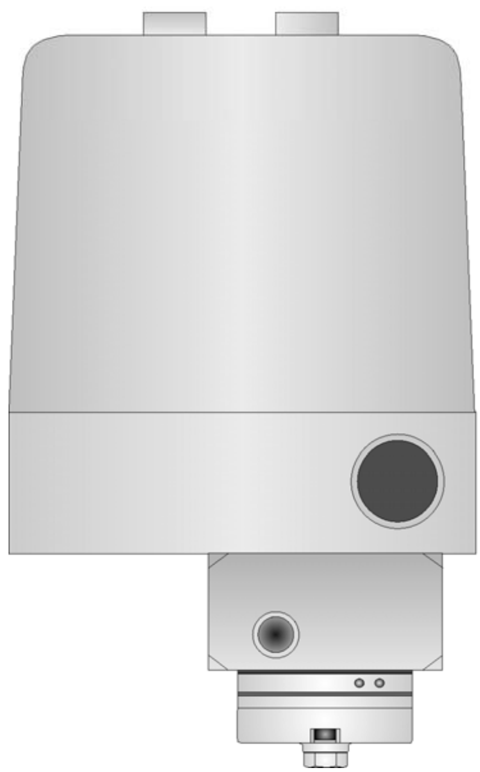
Instruction Manual
CI-9110
Mar. 2007

Series 9110

Remote Set Regulator
Model 9110-00A





Bristol

www.EmersonProcess.com/Bristol

EMERSON
Process Management

IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

Be sure that these instructions are carefully read and understood before any operation is attempted. Improper use of this device in some applications may result in damage or injury. The user is urged to keep this book filed in a convenient location for future reference.

These instructions may not cover all details or variations in equipment or cover every possible situation to be met in connection with installation, operation or maintenance. Should problems arise that are not covered sufficiently in the text, the purchaser is advised to contact Bristol for further information.

EQUIPMENT APPLICATION WARNING

The customer should note that a failure of this instrument or system, for whatever reason, may leave an operating process without protection. Depending upon the application, this could result in possible damage to property or injury to persons. It is suggested that the purchaser review the need for additional backup equipment or provide alternate means of protection such as alarm devices, output limiting, fail-safe valves, relief valves, emergency shutoffs, emergency switches, etc. If additional in-formation is required, the purchaser is advised to contact Bristol .

RETURNED EQUIPMENT WARNING

When returning any equipment to Bristol for repairs or evaluation, please note the following: The party sending such materials is responsible to ensure that the materials returned to Bristol are clean to safe levels, as such levels are defined and/or determined by applicable federal, state and/or local law regulations or codes. Such party agrees to indemnify Bristol and save Bristol harmless from any liability or damage which Bristol may incur or suffer due to such party's failure to so act.

ELECTRICAL GROUNDING

Metal enclosures and exposed metal parts of electrical instruments must be grounded in accordance with OSHA rules and regulations pertaining to "Design Safety Standards for Electrical Systems," 29 CFR, Part 1910, Subpart S, dated: April 16, 1981 (OSHA rulings are in agreement with the National Electrical Code).

The grounding requirement is also applicable to mechanical or pneumatic instruments that include electrically-operated devices such as lights, switches, relays, alarms, or chart drives.

EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

This product contains sensitive electronic components that can be damaged by exposure to an electrostatic discharge (ESD) voltage. Depending on the magnitude and duration of the ESD, this can result in erratic operation or complete failure of the equipment. Read supplemental document S14006 at the back of this manual for proper care and handling of ESD-sensitive components.

Bristol Inc. 1100 Buckingham Street, Watertown, CT 06795
Telephone (860) 945-2200

WARRANTY

A. Bristol warrants that goods described herein and manufactured by Bristol are free from defects in material and workmanship for one year from the date of shipment unless otherwise agreed to by Bristol in writing.

B. Bristol warrants that goods repaired by it pursuant to the warranty are free from defects in material and workmanship for a period to the end of the original warranty or ninety (90) days from the date of delivery of repaired goods, whichever is longer.

C. Warranties on goods sold by, but not manufactured by Bristol, are expressly limited to the terms of the warranties given by the manufacturer of such goods.

D. All warranties are terminated in the event that the goods or systems or any part thereof are (i) misused, abused or otherwise damaged, (ii) repaired, altered or modified without Bristol's consent, (iii) not installed, maintained and operated in strict compliance with instructions furnished by Bristol, or (iv) worn, injured or damaged from abnormal or abusive use in service time.

E. THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION WARRANTIES AS TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), AND NO WARRANTIES, EXPRESS OR IMPLIED, NOR ANY REPRESENTATIONS, PROMISES, OR STATEMENTS HAVE BEEN MADE BY BRISTOL UNLESS ENDORSED HEREIN IN WRITING. FURTHER, THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION OF THE FACE HEREOF.

F. No agent of Bristol is authorized to assume any liability for it or to make any written or oral warranties beyond those set forth herein.

REMEDIES

A. Buyer's sole remedy for breach of any warranty is limited exclusively to repair or replacement without cost to Buyer of any goods or parts found by Seller to be defective if Buyer notifies Bristol in writing of the alleged defect within ten (10) days of discovery of the alleged defect and within the warranty period stated above, and if the Buyer returns such goods to Bristol's Watertown office, unless Bristol's Watertown office designates a different location, transportation prepaid, within thirty (30) days of the sending of such notification and which upon examination by Bristol proves to be defective in material and workmanship. Bristol is not responsible for any costs of removal, dismantling or reinstallation of allegedly defective or defective goods. If a Buyer does not wish to ship the product back to Bristol, the Buyer can arrange to have a Bristol service person come to the site. The Service person's transportation time and expenses will be for the account of the Buyer. However, labor for warranty work during normal working hours is not chargeable.

B. Under no circumstances will Bristol be liable for incidental or consequential damages resulting from breach of any agreement relating to items included in this quotation, from use of the information herein or from the purchase or use by Buyer, its employees or other parties of goods sold under said agreement.

How to return material for Repair or Exchange

Before a product can be returned to Bristol for repair, upgrade, exchange, or to verify proper operation, form (GBU 13.01) must be completed in order to obtain a RA (Return Authorization) number and thus ensure an optimal lead time. Completing the form is very important since the information permits the Bristol Repair Dept. to effectively and efficiently process the repair order.

You can easily obtain a RA number by:

A. FAX
Completing the form (GBU 13.01) and faxing it to (860) 945-3875. A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

B. E-MAIL
Accessing the form (GBU 13.01) via the Bristol Web site (www.bristolbabcock.com) and sending it via E-Mail to brepair@bristolbabcock.com. A Bristol Repair Dept. representative will return E-Mail (or other requested method) with a RA number.

C. Mail
Mail the form (GBU 13.01) to

Bristol Inc.
Repair Dept.
1100 Buckingham Street
Watertown, CT 06795

A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

D. Phone
Calling the Bristol Repair Department at (860) 945-2442. A Bristol Repair Department representative will record a RA number on the form and complete Part I, then send the form to the Customer via fax (or other requested method) for Customer completion of Parts II & III.

A copy of the completed Repair Authorization Form with issued RA number should be included with the product being returned. This will allow us to quickly track, repair, and return your product to you.

Bristol Inc. Repair Authorization Form (off-line completion)

(Providing this information will permit Bristol Inc. to effectively and efficiently process your return. Completion is required to receive optimal lead time. Lack of information may result in increased lead times.)

Date___________________ **RA #**___________________**SH_** **Line No.**____________

Standard Repair Practice is as follows: Variations to this is practice may be requested in the "Special Requests" section.

- Evaluate / Test / Verify Discrepancy
- Repair / Replace / etc. in accordance with this form
- Return to Customer

Please be aware of the Non warranty standard charge:

- There is a $100 minimum evaluation charge, which is applied to the repair if applicable (√ in "returned" B,C, or D of part III below)

Part I **Please complete the following information for single unit or multiple unit returns**

Address No. ________________________ **(office use only)** **Address No.** ________________________ **(office use only)**

Bill to :____ **Ship to:**____

Purchase Order:_________________________________ **Contact Name:**___________________________________

Phone:__________________________ **Fax:**__________________________**E-Mail:** ______________________________

Part II **Please complete Parts II & III for each unit returned**

Model No./Part No._________________________________ **Description** ______________________________

Range/Calibration _________________________________ **S/N** ___________________

Reason for return : ☐ Failure ☐ Upgrade ☐ Verify Operation ☐ Other ______________________________

1. Describe the conditions of the failure (Frequency/Intermittent, Physical Damage, Environmental Conditions, Communication, CPU watchdog, etc.)

____(Attach a separate sheet if necessary)

2. Comm. interface used: ☐ Standalone ☐ RS-485 ☐ Ethernet ☐ Modem (PLM (2W or 4W) or SNW) ☐Other:_______________
3. What is the **Firmware** revision? ______________________ What is the **Software** &version? ____________________

Part III If checking "replaced" for any question below, check an alternate option if replacement is not available

A. If product is within the warranty time period but is excluded due to Bristol's warranty clause, would you like the product: ☐ repaired ☐ returned ☐ replaced ☐ scrapped?

B. If product were found to exceed the warranty period, would you like the product: ☐repaired ☐ returned ☐ replaced ☐ scrapped?

C. If product is deemed not repairable would you like your product: ☐ returned ☐ replaced ☐ scrapped?

D. If Bristol is unable to verify the discrepancy, would you like the product: ☐ returned ☐ replaced ☐ *see below?

* Continue investigating by contacting the customer to learn more about the problem experienced? The person to contact that has the most knowledge of the problem is: ______________________________ phone_____________________

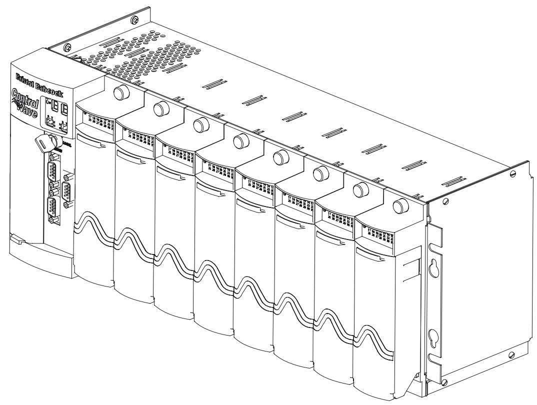
If we are unable to contact this person the backup person is: _________________________ phone______________________

Special Requests: ____

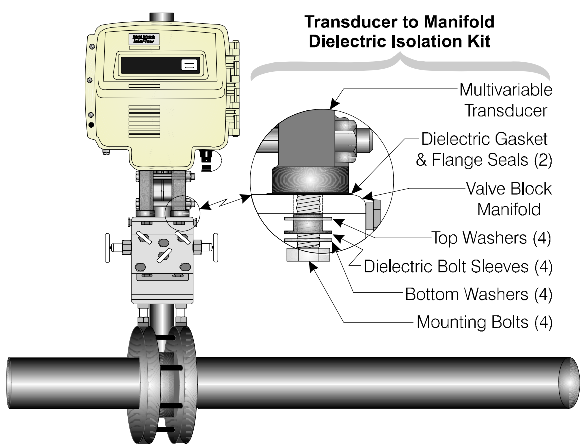
Ship prepaid to: **Bristol Inc., Repair Dept., 1100 Buckingham Street, Watertown, CT 06795**
Phone: 860-945-2442 Fax: 860-945-2220

Bristol
Training

GET THE MOST FROM YOUR BRISTOL BABCOCK INSTRUMENT OR SYSTEM



- Avoid Delays and problems in getting your system on-line
- Minimize installation, start-up and maintenance costs.
- Make the most effective use of our hardware and software.
- Know your system.



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For information or to enroll in any class, contact our training department in Watertown at (860) 945-2343. For Houston classes, you can also contact our Houston office, at (713) 685-6200.

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For over 100 years, Bristol® has been providing innovative solutions for the measurement and control industry. Our product lines range from simple analog chart recorders, to sophisticated digital remote process controllers and flow computers, all the way to turnkey SCADA systems. Over the years, we have become a leading supplier to the electronic gas measurement, water purification, and wastewater treatment industries.

On off-shore oil platforms, on natural gas pipelines, and maybe even at your local water company, there are Bristol Inc. instruments, controllers, and systems running year-in and year-out to provide accurate and timely data to our customers.

Getting Additional Information

In addition to the information contained in this manual, you may receive additional assistance in using this product from the following sources:

Help Files / Release Notes

Many Bristol software products incorporate help screens. In addition, the software typically includes a 'read me' release notes file detailing new features in the product, as well as other information which was available too late for inclusion in the manual.

Contacting Bristol Inc. Directly

Bristol's world headquarters is located at 1100 Buckingham Street, Watertown, Connecticut 06795, U.S.A.

Our main phone numbers are:

(860) 945-2200
(860) 945-2213 (FAX)

Regular office hours are Monday through Friday, 8:00AM to 4:30PM Eastern Time, excluding holidays and scheduled factory shutdowns. During other hours, callers may leave messages using Bristol's voice mail system.

Telephone Support - Technical Questions

During regular business hours, Bristol's Application Support Group can provide telephone support for your technical questions.

For technical questions about TeleFlow products call (860) 945-8604.

For technical questions about **Control**Wave call (860) 945-2394 or (860) 945-2286.

For technical questions regarding Bristol's **OpenEnterprise** product, call (860) 945-3865 or e-mail: **scada@bristolbabcock.com**

For technical questions regarding **ACCOL** products, **OpenBSI Utilities**, **UOI** and all other software except for **Control**Wave and **OpenEnterprise** products, call (860) 945-2286.

For technical questions about **Network 3000** hardware, call (860) 945-2502.

You can e-mail the Application Support Group at: **bsupport@bristolbabcock.com**

The Application Support Group maintains an area on our web site for software updates and technical information. Go to: **www.bristolbabcock.com/services/techsupport/**

For assistance in interfacing Bristol hardware to radios, contact Bristol's **Communication Technology Group** in Orlando, FL at **(407) 629-9463 or (407) 629-9464**.

You can e-mail the Communication Technology Group at:
orlandoRFgroup@bristolbabcock.com

Telephone Support - Non-Technical Questions, Product Orders, etc.

Questions of a non-technical nature (product orders, literature requests, price and delivery information, etc.) should be directed to the nearest sales office (listed on the rear cover of this manual) or to your Bristol-authorized sales representative.

Please call the main Bristol Inc. number (860-945-2200) if you are unsure which office covers your particular area.

Visit our Site on the World Wide Web

For general information about Bristol Inc. and its products, please visit our site on the World Wide Web at: **www.bristolbabcock.com**

Training Courses

Bristol's Training Department offers a wide variety of courses in Bristol hardware and software at our Watertown, Connecticut headquarters, and at selected Bristol regional offices, throughout the year. Contact our Training Department at **(860) 945-2343** for course information, enrollment, pricing, and scheduling.

CI-9110
MODEL 9110-00A REMOTE SET REGULATOR

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Chapter 1

INTRODUCTION

1.1 PRODUCT DESCRIPTION

Series 9110-00A, Remote Set Regulators are transducer devices that use an electrical input signal to set the level of a pneumatic output signal. Depending on the actual model, the electrical input may be either an analog or a raise/lower type signal. For analog models, the input can be configured for a 1-5 V dc or 4-20 mA dc signal. For the Raise/Lower models, the input can be configured to accept a continuous or pulse incremental dc signal.

The pneumatic output of a Remote Set Regulator may be specified with a 3-15, 3-27 or 6-30 psi output. All models can operate from pressure supplies up to 100 psi (Max). Minimum supply pressure must be at least 3 psi above the maximum range value.

The Regulator also provides a guard input. This signal can be used to Enable (turn ON) or Inhibit (turn OFF) the input for telemetry and security applications. When the guard signal is Enabled, it allows the output to respond to a change of the input signal.

The Remote Set Regulator is contained in a weatherproof, explosion-proof enclosure having a detachable threaded cover. Removal of the cover provides access to the field wiring terminals and the programmable option switches.

Regulators are factory-furnished for 12 Vdc or 24 Vdc supply operation. These voltage ratings are fixed and cannot be changed in the field.

In-line or pipe mounting are offered as for installations. The former uses a 1/4 inch rigid pressure line for support, while the latter includes a special bracket for two-inch pipe mounting.

1.2 THEORY OF OPERATION

The Remote Set Regulator contains a CPU Board and a Termination Board. The CPU Board contains the central processor and its associated circuitry, while the Termination Board contains the field wiring terminals and the input protection circuitry.

The Regulator is offered in Analog and Raise/Lower models. Both types use similar circuitry but they perform different functions. A description of the Analog model follows while the Raise/Lower model is explored later in the text.

1.2.1 Analog Regulator Model

The Analog Regulator circuitry is shown in the block diagram of Figure 1-2. In this circuit, the Command signal (1-5 V or 4-20 mA) is applied to a buffer amplifier which drives the plus (+) input of the Lower Comparator and the minus (-) input of the Raise Comparator. Also note that the opposing inputs of both comparators are referenced to the same point which is the center arm of a feedback pot.

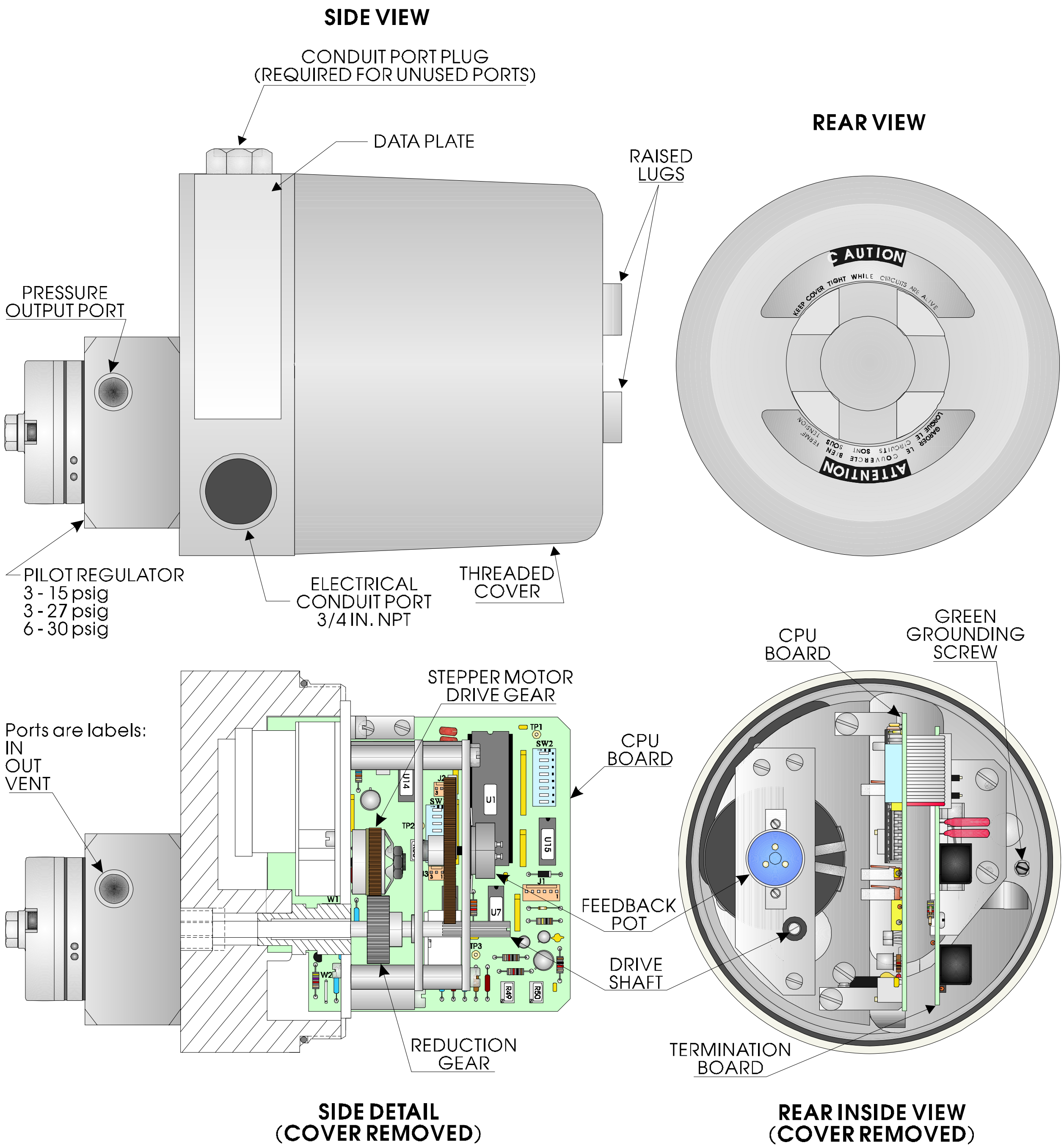


Figure 1-1 - Remote Set Regulator

The CPU, clock and reset circuitry performs the timing, measurement and decision making functions of the Remote Set Regulator. This circuit analyzes the comparator outputs and sends data to the stepper driver which, in turn, pulses the stepper motor in either direction. Since the driveshaft of the stepper motor is mechanically coupled to the feedback pot and a pressure regulator valve, both will be set in accordance with data received from the CPU.

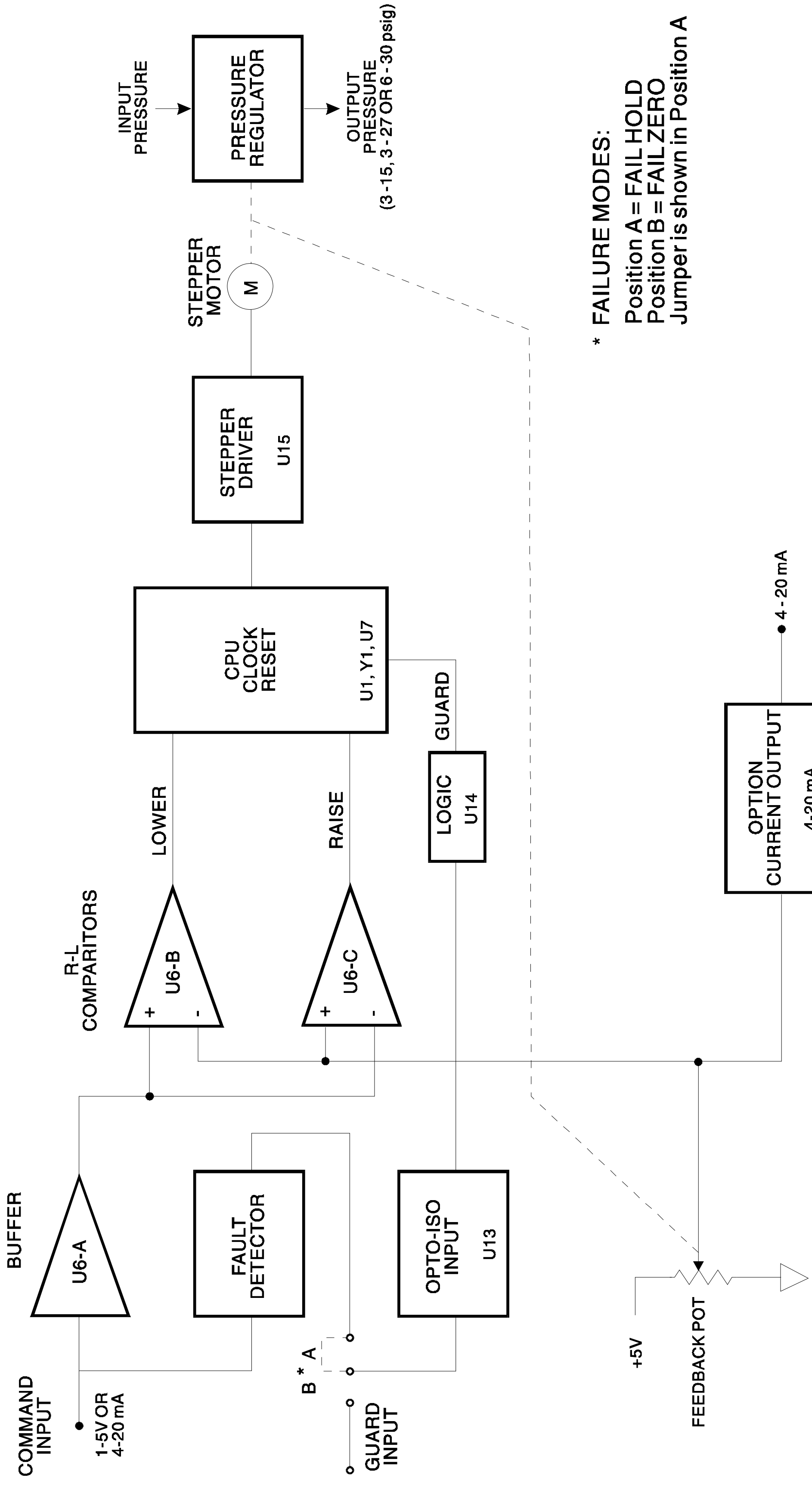


Figure 1-2 - Block Diagram of Analog Type Regulator

The feedback pot connects across a regulated +5 Vdc source. The voltage at the feedback pot's contact corresponds to the mechanical position of the pressure regulator. This reference voltage is applied to the Raise and Lower Comparators.

If an increase in signal level occurs at the command input, the Raise Comparator will become unbalanced since this signal will exceed the voltage present at the center arm of the pot. The Lower Comparator will be unaffected since the input signal will be of opposite polarity compared to the feedback pot voltage. The CPU senses the increased output at the Raise Comparator and outputs a signal that drives the stepper motor in an upward direction. The upward driving action will continue until the voltage at the pot's center arm becomes equal to the new signal level. Once the comparator is balanced, the CPU will turn off the stepper motor and the pressure regulator will provide a corresponding pressure output level. Input changes that reduce the output value will have the opposite effect.

The comparators are biased so that they include a certain amount of hysteresis. This bias keeps the stepper motor in a stable, deenergized zone that is less affected by noise bursts that may appear on the command input line.

The stepper motor is actuated in incremental steps. The pulse signals received from the stepper driver will increment the motor one step at a time. The motor requires approximately 22,000 steps for full rotation.

1.2.2 Guard Input

An optional signal can be applied to the guard input to Enable or Inhibit the command Signal. The guard circuit consists of a non-polarized, opto-isolated circuit whose output is applied to the CPU via a logic circuit.

Analog Regulator models include a fault detector circuit that is activated through jumper selection. The fault detector monitors the analog input value for a value that is less than 0% of scale. This condition, which occurs when the AI command input signal fails, will stop the stepper motor and maintain the last output value prior to the failure.

Two types of signal failure modes are provided by jumper selection as shown at the left of Figure 1-2. Position "A" of the jumper provides fail-hold mode, while position "B" provides fail-hold zero. Should the AI signal fail (signal < 0% of scale), fail-zero mode will drive the output slowly to zero, while fail-hold mode will retain its last output value.

Mechanical limiting is also provided by adjustable tangs located on the main drive gear of the stepper motor. When the input signal is of a value that causes the stepper to drive against a limit, a mechanical clutch on the drive shaft will slip. After making several revolutions, the software will time out and cut off power to the motor. Power will be reapplied when the signal level returns to the normal operating range.

1.2.3 Current Output

A 4-20 mA current output is obtained via an amplifier/converter circuit. The input to this circuit is the feedback pot whose center arm adjusts the current output to track the valve position.

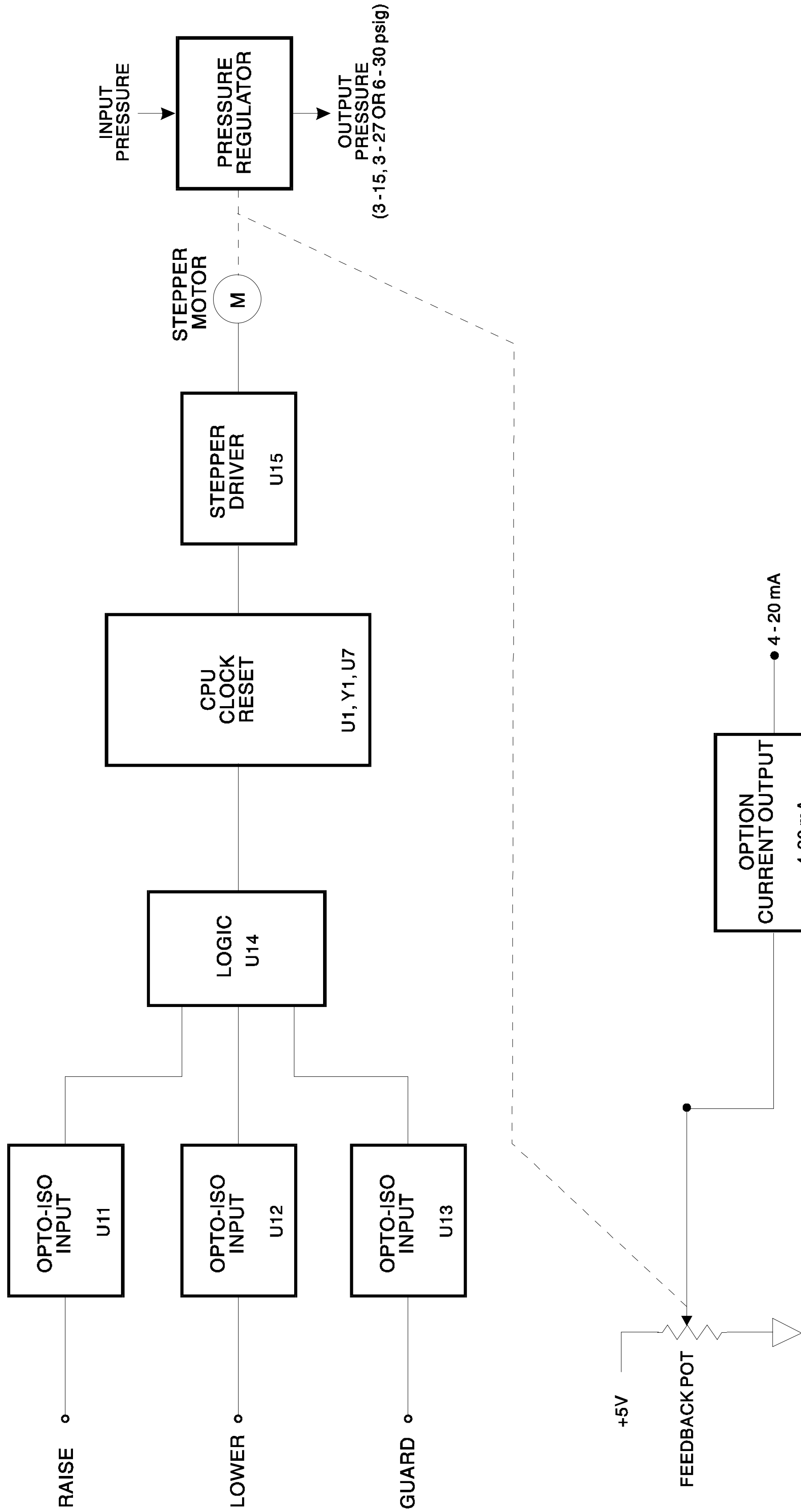


Figure 1-3 - Block Diagram of Raise/Lower Type Regulator

1.2.4 Raise/Lower Regulator Model

A block diagram for the Raise/Lower Regulator model is shown in Figure 1-3. It will be noted that this diagram is similar to the Analog Regulator except for the input circuit arrangement. This circuit contains Raise, Lower and Guard input circuits which are opto-isolated.

The outputs of all three opto-isolators are applied to a logic circuit that checks the status of the three signals and determines whether the output will be in a Raise, Lower or Guard mode.

Each Raise and Lower input may be configured to accept a continuous or pulse incremental signal. The continuous signal is a dc input that, when switched to an ON state, allows the stepper motor to rotate in the proper direction; when switched to an OFF state, it stops the stepper motor and maintains a corresponding output value. The pulse incremental signal can be a single dc pulse or a pulse train input that causes stepper motor to change the output by an incremented amount. The amount of the output increment is determined by the settings of the configuration switches.

The outputs of all three opto-isolators in Figure 1-3 are status signals that, when processed by the CPU, establish a pressure output value that corresponds to the input signals. The remainder of the circuitry shown in the illustration operates in the same manner as described for Analog Regulators.

1.3 DATA PLATE

A data plate affixed to the Remote Set Regulator lists the instrument model, serial number and other relevant information. The features and options present in an instrument can be determined by comparing its model number to the model breakdown of Table 1-A.

Remote Set Regulators certified for use in hazardous areas will include the seal of the certifying laboratory on the data plate. Certification will also be indicated as an element of the instrument model number listed on the data plate.

Table 1A - Model Number Breakdown

- SAMPLE MODEL NUMBER -

```
9110-11A  - 1 2 2  -  1 1  <---  Model No.
    |       | | |     | |
    |       | | |     | |
    #       A B C     D E  <---  Position
```

 # = BASE MODEL NUMBER

A = ELECTRICAL INPUT

1 = Raise/lower Input
2 = Analog Input (1-5V or 4-20 mA)

B = POWER

1 = 12V dc
2 = 24V dc

Table 1A - Model Number Breakdown (Continued)

C = PNEUMATIC OUTPUT

1 = 3-15 psi
2 = 3-27 psi
3 = 6-30 psi

D = MOUNTING ARRANGEMENT

1 = 2 In. Pipe Mtg. Bracket
2 = In-Line Pressure Pipe

E = CERTIFICATION

1 = None
2 = FM-EXP/NI
3 = CSA-EXP

NOTE: This table is only provided for product identity and not for ordering purposes. Contact the Bristol Sales Department for ordering information.

Chapter 2
INSTALLATION

2.1 GENERAL

Proper installation techniques will ensure highest performance and also minimize measurement errors. The Remote Set Regulator should be mounted in a location that is not subject to radical temperature extremes, vibration and shock. See Section 6 Specifications for environmental operating conditions.

This section describes the mechanical mounting arrangements of the Regulator and explains the technique of bringing in wiring via electrical conduit.

The installation procedures described herein are furnished as a guideline and cannot cover all possible variations. All deviations from the installation procedures described herein are at the discretion of the user.

2.2 MOUNTING

The overall mounting dimensions for the unit are given in Figure 2-1. Be sure that the selected site has sufficient clearance to remove the Regulator cover and access internal switches and terminals. Choose the appropriate mounting arrangement below as required

2.2.1 Two-Inch Pipe Mounting

Refer to the overall dimension of Figure 2-1 for views of the universal pipe mounting bracket. For this type of installation, the bracket is assembled to the Regulator using three screws. Select the desired set of bracket holes for either vertical or horizontal mounting pipes.

Once the bracket is mounted, position the assembly next to the pipe as required and install the u-bolts from the hardware kit into the appropriate bracket holes. Install nuts on the u-bolts and tighten them until the instrument is self-supporting.

2.2.2 In-Line Mounting

In-line mounting can be used when the pressure line and electrical conduit provide sufficient strength to support the weight of the unit. This type of mounting should never be attempted on lines constructed of soft or low-strength materials. In-line mounting is also not recommended for non-secured lines subject to excessive vibration or hammering.

Once the desired location has been selected, cut the pressure pipe and install proper fittings (1/4 in. NPT male) to mate with the two pressure connection ports on the Regulator. It is recommended that unions and shutoff valves also be installed in each line to allow an easy disconnect for maintenance or troubleshooting operations.

2.3 PRESSURE CONNECTIONS

Remote Set Regulators are furnished in models that provide 3-15, 3-27 or 6-30 psig outputs. All models will accept 100 psig maximum on the supply side. Pressure supplies that exceed this value will require an external pressure regulator or limiter.

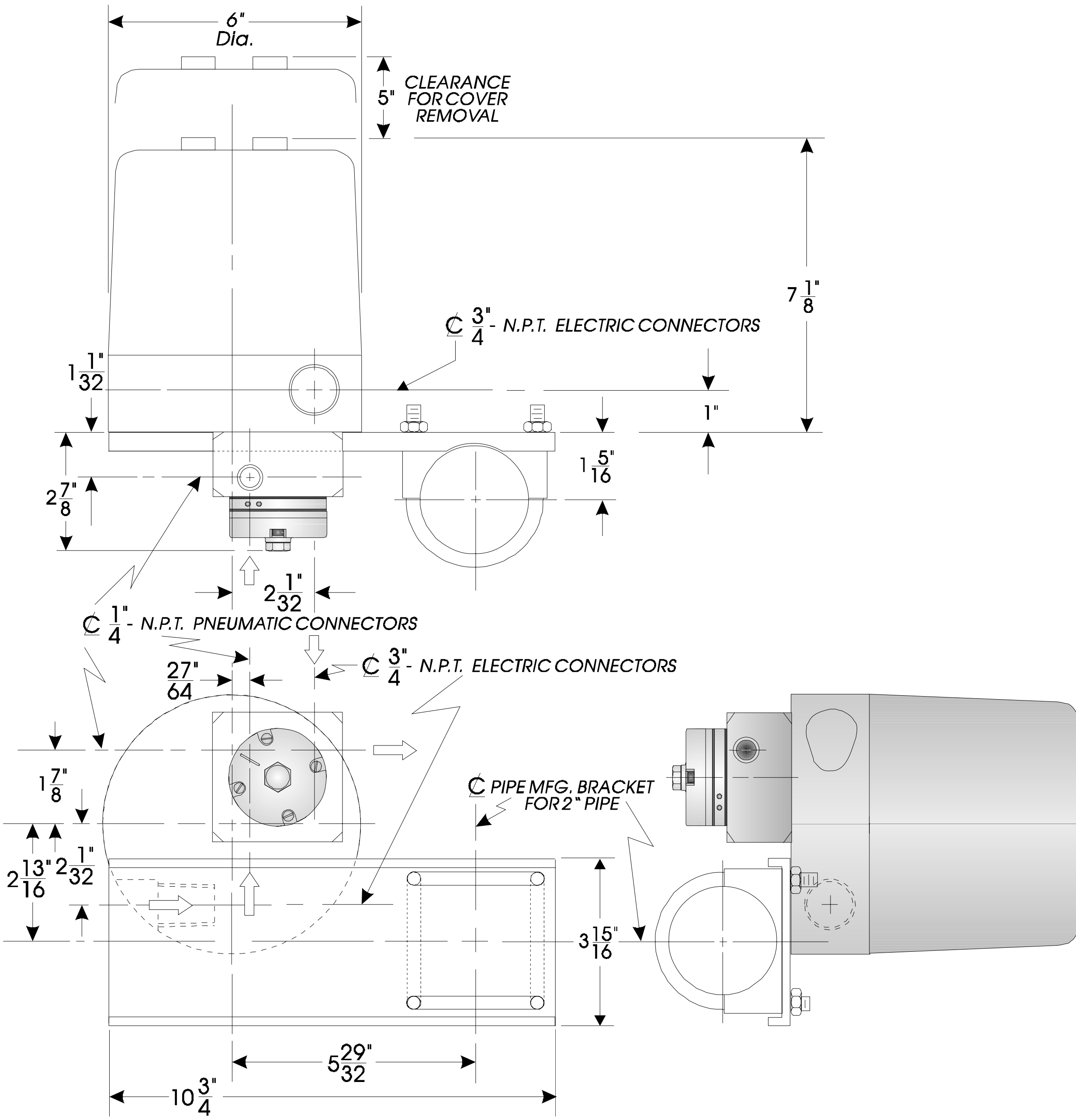


Figure 2-1 - Overall Mounting Dimensions

2.3.1 General Piping

A basic piping diagram is shown in Figure 2-3. The pressure supply line may include a pressure gauge, external regulator, filter and a shutoff valve as shown. Union type connections are recommended for pressure lines to allow an easy disconnect. A pressure shutoff valve allows the supply source to be closed down during maintenance checks without disturbing other equipment operating on the line.

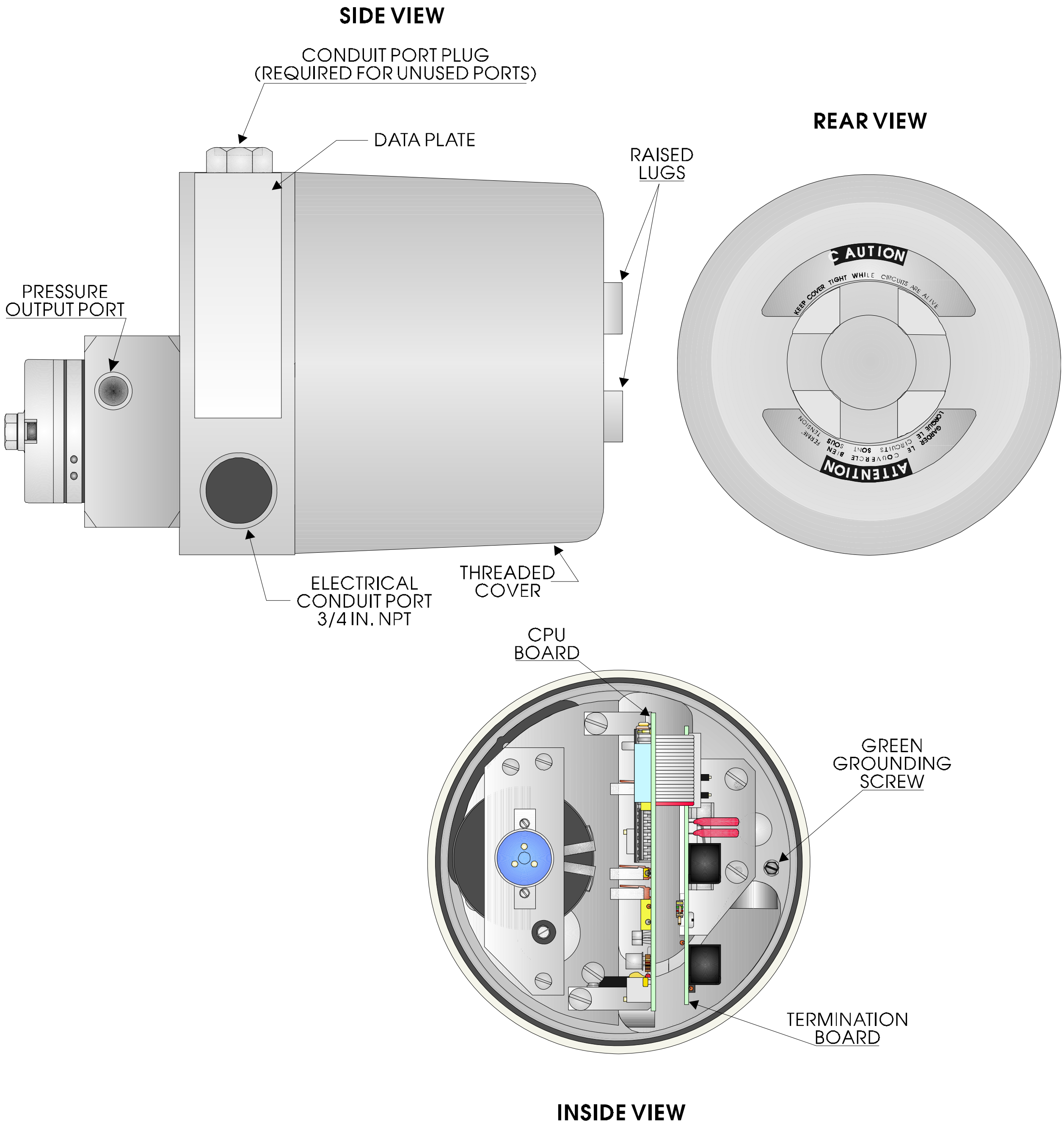


Figure 2-2 - Regulator Assembly

2.3.2 Moisture in Lines

The Regulator should be installed so that the supply and output lines slope downward and away. This arrangement allows any condensate trapped in the lines to drain away from the instrument.

2.3.3 Line Size

For most installations 1/4 inch pipe or tubing is satisfactory. However, if the input or output lines run a great distance, the response lag time may become objectionable. In these instances the use of 3/8 inch tubing is recommended.

2.3.4 Venting

The user should note that the Remote Set Regulator bleeds a small amount of pressure into the atmosphere during operation. A 1/4 inch NPT vent is provided on the pressure regulator body for this purpose. The vent location is shown in Figure 2-3.

When air is used as the pressure source, the vent fitting may be allowed to bleed into the atmosphere. If fuel gas or other hazardous type gases are used as the pressure source for a Remote Set Regulator, the VENT port must be piped to a safe location.

**** Warning ****

Covers of Remote Set Regulators operating in hazardous areas should not be removed. If servicing is required, the environment should first be made safe or the supply power should be turned off, allowing the instrument to be disconnected and removed to a safe area.

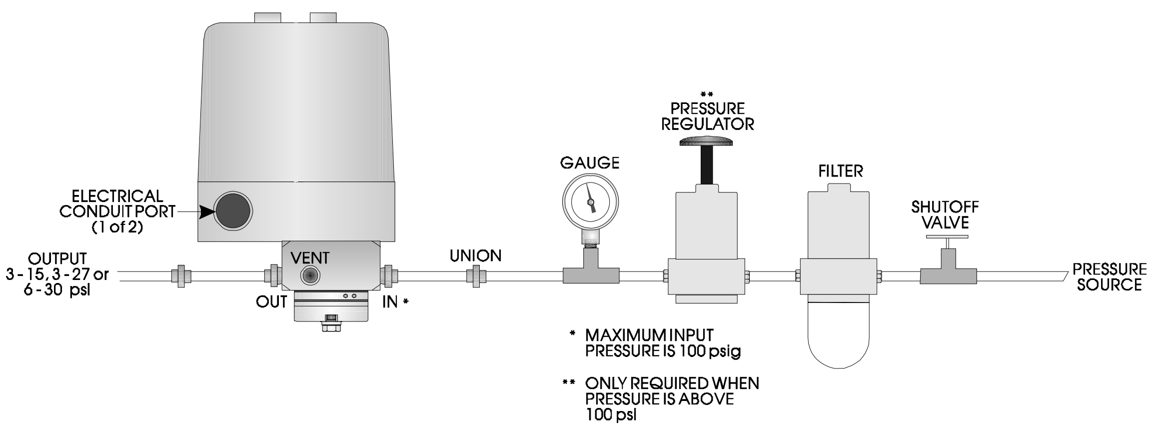


Figure 2-3 - Typical Pressure Connections

2.4 INTERNAL ACCESS

The subtopics that follow discuss the main mechanical and electrical assemblies that will be accessed during installation. They describe the method of removing and installing the cover, the use of the electrical conduit ports, and the installation precautions to be observed.

2.4.1 Body and Cover

The Remote Set Regulator is contained in a aluminum body with a gasketed screw-on cover as shown in Figure 2-2. Four raised lugs on the cover permit it to be loosened or tightened using a flat metal bar or similar tool. When replacing the cover, it should be snugged in and not over-tightened. The threads of the cover should also be coated with a layer of anti-seize compound to prevent lockup.

When the cover is removed, the PC board assemblies become accessible (see right view of Figure 2-3). The Termination Board contains the field wiring terminals while the CPU Board contains the option switches. The gear mechanism and feedback potentiometer are also accessible.

2.4.2 Electrical Conduit Port

Two 3/4 in. NPT electrical ports are provided at the lower part of the housing. Either or both ports may be used to bring in signal and supply wiring (left of Figure 2-3). These ports accommodate a standard 3/4 inch NPT pipe thread connection. If a port is not used, it must have a conduit plug installed to maintain the explosion-proof integrity of the unit.

2.5 INSTALLATION IN HAZARDOUS LOCATIONS

Instruments that operate in hazardous locations must adhere to the following rules of safety:

A. All instrument wiring that runs through a hazardous area must be enclosed in metal conduit. The point where the conduit connection meets the unit's housing should be properly tightened to prevent entry of gas or other ignitable substances. Explosion-proof wiring practices must be followed to prevent flashback through the conduit.

B. The cover of the installed unit must be screwed in hand tight and fully seated. The cover must not be damaged and no threads should be stripped.

C. The cover of the unit must never be removed during operation unless the atmosphere is made safe or all electrical power is removed from the instrument.

**** Warning ****

No maintenance procedures should be performed while the unit is powered and operating in a combustible or explosive environment. If on-site maintenance is a necessity, steps must be taken to make the environment safe (non-hazardous). Otherwise, the instrument must be powered down, unwired, and brought into a safe area. A failure to observe these precautions could result in fire or explosion and injury to persons.

**** Safety Note ****

For certified instruments, all installation and operating practices must conform to area classification and safety codes as specified by the certifying laboratory. The seal of the certifying laboratory will appear on the instrument data plate along with the model and serial number.

Chapter 3
BOARD SETUP

3.1 USING OPTION SWITCHES

Two switch assemblies (SW1 and SW2) are used to set options and select ranges. These switches are located on the CPU Board as shown in Figure 3-1. Each assembly contains eight (8) miniature SPST switches. The individual switches of each package are identified as subsets of the main switch, e.g., SW1-1, SW1-2, etc.

Two types of switch assemblies are used for Regulators. One type uses cradle switches, while the other uses slide-type switches. The operation of each type differs as follows:

Cradle Switches with OPEN Designation:

OPEN side pressed down = OFF (open circuit)
Numbered side pressed down = ON (closed circuit)

Slide Switches with ON Designation:

Set in direction of ON arrow = ON (closed circuit)
Set in opposite direction of arrow = OFF (open circuit)

The switch assemblies are fragile and require careful handling. Use a small, blunt object such as a miniature screwdriver to set the switch positions. Do not use pencils, ballpoint pens, or extremely sharp objects for this purpose.

WARNING

When starting a unit for the first time, all switch options must be set before any power is applied. Improper switch settings can cause improper operation or dangerous control situations that could damage process equipment and property, or cause injury to persons.

NOTE

Attempting to change settings of any switch (excluding SW2-6 and SW2-8) while the unit is on line will not produce a change of configuration. Although the switches have been set, the configuration will not take effect until the power applied to the Regulator has been turned OFF and, after a moment, turned back ON again.

If switch settings are changed without turning the power OFF, the present on-line configuration will remain in effect until the unit is turned OFF and powered up again.

3.1.1 Switch Functions

The Regulator assembly is configured by two, eight-switch packages which perform the functions listed in Table 3-1.

Table 3-1 - Regulator Assembly Switch SW1 & SW2 Functions & Settings

Switch Label	Switch Function	Page Ref.	* Your Setting	** Your Notes
SW1-1	R/L % per pulse increment	3-4		
SW1-2	R/L % per pulse increment	3-4		
SW1-3	R/L % per pulse increment	3-4		
SW1-4	R/L % per pulse increment	3-4		
SW1-5	R/L % per pulse increment	3-4		
SW1-6	Not Used	None		
SW1-7	Not Used	None		
SW1-8	Input Filter	3-4		
SW2-1	Guard (Dynamic/Static)	3-5		
SW2-2	Actuator Output Rate of Change	3-6		
SW2-3	Actuator Output Rate of Change	3-6		
SW2-4	Actuator Output Rate of Change	3-6		
SW2-5	Actuator Output Rate of Change	3-6		
SW2-6	Guard (Active/Inactive)	3-5		
SW2-7	Not Used	None		
SW2-8	Analog Input (V or I)	3-2		

* Record your switch settings (ON or OFF) here for future reference.
** List your corresponding switch functions or values here.

3.2 ANALOG INPUT MODELS

Initially, it will be necessary to check the position of switches SW1-1 through SW1-5. These switches must be set to their OPEN positions to properly disable the functions associated with Raise/Lower models. The other uses of these switches are described under topic 3.3.

Analog models can be set to accept a 4-20 mA or 1-5 V dc signal at the Command Input. Switch SW2-8 selects these outputs as follows:

SW2-8	Analog Range
Close	4-20 mA dc
Open	1-5 V dc

3.3 RAISE/LOWER INPUT MODELS

Raise/Lower Actuator models can be set for continuous or incremental-type input signals via switches SW1-1 through SW1-5. The switch positions are shown in Table 3-2. The switch selections are described as follows:

3.3.1 Continuous Signal

A continuous input signal is one that, when placed in a TRUE state, will cause the output to change until the input is set FALSE. To achieve this mode of operation, all five switches of SW1 should be set to the OPEN position (bottom condition of Table 3-2). This will configure the Regulator so that its output will change as long as the one signal applied to the Raise and Lower Command Inputs is TRUE (dc = ON) and the other is FALSE (dc = OFF). No other change will occur when both inputs are simultaneously set FALSE or TRUE.

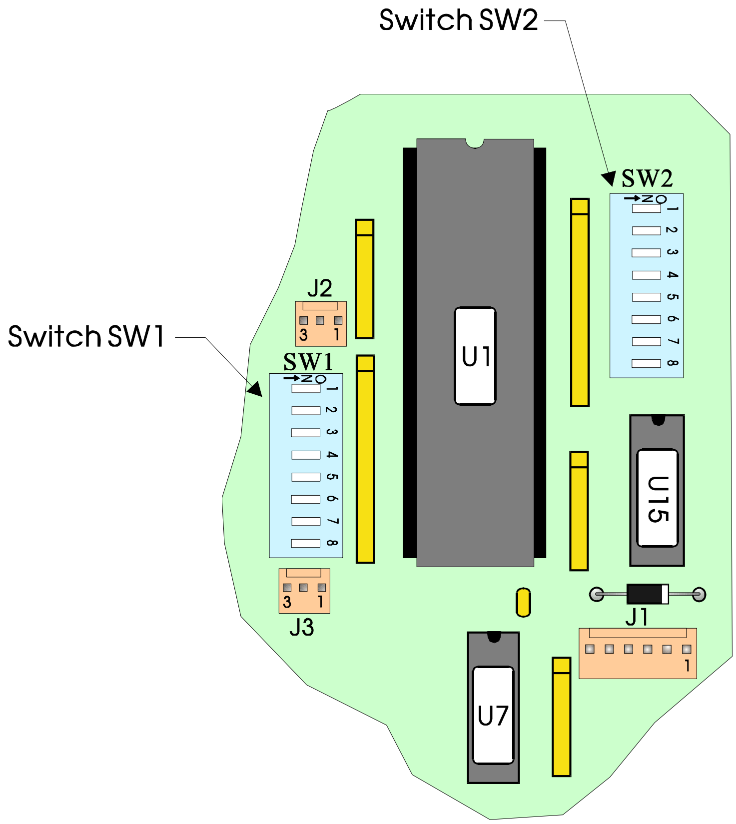


Figure 3-1 - Option Switches on CPU Board

3.3.2 Incremental Signal

The five switches can be set for any increment from 0.110% per pulse to 1.830% per pulse. The pulses that raise or lower the output perform in real time and are not stored. As a requirement, each pulse must remain in a TRUE state for a period of time necessary for the Remote Set Regulator to reach the new output value. Should the input change from a raise to a lower operation (or vice-versa) before the completion of an incremental step, the unfinished increment will be cut off and the next pulse will be freshly processed.

A unit that is set up with a slower rate of change value or a greater percent of full scale change per input pulse will require a longer input pulse. Therefore, the minimum time period required for an ON and OFF pulse to produce an output change is dependent upon the settings of switches SW1 (1-5). There are no maximum limits for either the ON or OFF pulse periods (time between pulses).

The relationship between an ON and OFF pulse time periods are shown by the following two equations:

1) T on Minimum (sec.) = (.01 SR) + K
2) T off Minimum (sec.) = K

Where:

T on Minimum = Raise, Lower or Guard pulse
T off Minimum = Time between pulses.
S = Incremental step value (Table 3-2)
R = Rate of output change (Table 3-3)
K = .04 sec. with R/L filter active or 0.01 sec. with R/L filter turned off. See Section 3.6 - "Output Rate of Change."

Table 3-2 - Switch SW1 (1-5), Pulse Increments

SW1-5	SW1-4	SW1-3	SW1-2	SW1-1	Output Change (nominal, ±15%)
Close	Close	Close	Close	Close	Disabled
Close	Close	Open	Open	Close	0.110% / Pulse
Open	Close	Close	Close	Open	0.182% / Pulse
Open	Close	Close	Open	Close	0.365% / Pulse
Open	Close	Open	Close	Close	0.730% / Pulse
Open	Close	Open	Open	Close	1.090% / Pulse
Open	Close	Open	Open	Open	1.280% / Pulse
Open	Open	Close	Close	Close	1.460% / Pulse
Open	Open	Close	Close	Open	1.640% / Pulse
Open	Open	Close	Open	Close	1.830% / Pulse
Open	Open	Open	Open	Open	Continuous *

**Analog Regulator models must always have these switches set for Continuous Mode.*

3.4 INPUT FILTER

A raise or lower input signal can contain noise pulses of an amplitude sufficient to affect the output. In these situations, switch SW1-8 can be set to activate an input filter. The switch positions are given below. For Analog models, this switch must always be set to OPEN.

SW1-8	Filter Status
Close	Active
Open	Inactive

3.5 GUARD INPUT

The guard input (TB1-5 & TB1-6) is used to Enable or Inhibit the command input. This feature provides assurance that the command input will read its signal only during a security period selected by the user. The guard input can be used with either Analog or Raise/Lower (R/L) models.

3.5.1 Guard Logic

The guard logic can be set for logical operation so that a TRUE-state signal “enables” the Command input, while a FALSE-state signal “inhibits” it. The Guard input logic can also be set internally so that it is kept ON continuously; in this mode the Command input will be “enabled” at all times. Switch SW2-6 is used to set the guard mode as follows:

SW2-6	Guard Mode
Open	Active (Guard signal must be in TRUE state to accept input)
Close	Inactive (All inputs accepted)

3.5.2 Static or Dynamic Guard Input

The Guard input may be set to operate in a static or dynamic mode. The static mode, which can be used with either Analog or Raise/Lower command signals, allows the output to respond to a Command signal only when the Guard terminal is in a TRUE state.

The dynamic mode, which is only available with Raise/Lower models, responds to the simultaneous transition of two pulse-type signals. Consequently, the output will only change when a guard pulse and a command pulse (either a raise or lower) occur at the same moment. Furthermore, both pulses must remain TRUE until the actuator output change is complete. If either a guard or command pulse is not completed before the specified time, the pressure output will be held at its last value until a new change occurs. This arrangement can be used to obtain greater system security from extraneous signals and signal failure. This feature should not be used with Analog models.

The selection of static or dynamic mode is obtained via switch SW2-1 as follows:

SW2-1	Guard Status
Close	Dynamic (R/L type only)
Open	Static (AI or R/L types) *

* The "Open" position must always be used when "Fail Zero" mode is selected (see Section 3.7 - "Analog Failure Modes").

3.6 OUTPUT RATE OF CHANGE

The Regulator includes provisions for changing the time required by the stepper motor to sweep the entire pressure output range. This feature, which is available on both Analog and Raise/Lower models, is implemented by setting switches SW2-2 through SW2-5 as noted in Table 3-3.

Table 3-3 - Switch SW2 (2-5), Output Rate Of Change

SW2-5	SW2-4	SW2-3	SW2-2	Nominal Rate Of Change, ±15%
Close	Close	Close	Close	1.8 Min. Full Scale Travel
Close	Close	Close	Open	5.5 Min. Full Scale Travel
Close	Close	Open	Close	11.0 Min. Full Scale Travel
Close	Close	Open	Open	16.5 Min. Full Scale Travel
Close	Open	Close	Close	21.9 Min. Full Scale Travel
Close	Open	Open	Close	32.9 Min. Full Scale Travel
Close	Open	Open	Open	38.3 Min. Full Scale Travel
Open	Close	Close	Open	43.8 Min. Full Scale Travel
Open	Close	Open	Open	60.3 Min. Full Scale Travel
Open	Open	Close	Close	65.85 Min. Full Scale Travel
Open	Open	Close	Open	69.4 Min. Full Scale Travel

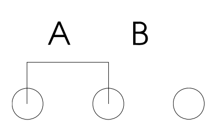
3.7 ANALOG FAILURE MODES (Fail Hold & Fail Zero)

Analog models have an "Analog Fault Detector" feature which, when selected by jumpers on the Termination Board, provides a selection of two failure modes, Fail Hold and fail Zero. In the "Fail Hold" mode, the Analog Fault will stop the stepper motor at the last pressure output value prior to the loss of the analog input signal. Note that the Guard terminals are not available for external usage in this mode. The Fault Detector trip point for this mode is factory set at 0.8 volts which corresponds to -5% of fullscale.

In the alternate "Fail Zero" mode, the Guard terminals are available for use with an external signal. In this mode, the analog input signal is “enabled” by a signal at the Guard terminal. If the input drops to zero while the Guard signal remains TRUE, the output will also go to zero.

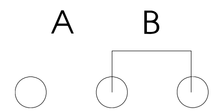
The selection of either failure mode is accomplished via two jumpers, W1 and W2. These jumpers are located on the Termination Board as shown in Figure 3-2. These jumpers may be plugged in position A or B; however, both jumpers must always be in the same position.

The configurations are selected as follows:



FAIL-HOLD MODE
(Both Jumpers in A position)

In the "A" position, a failure of the AI Command Input (value fails below 0%) causes the pressure output to remain at the value of the last valid sampling period. This condition is maintained until a normal AI is received.



FAIL-ZERO MODE
(Both Jumpers in B position)

In the "B" position (if the Guard signal remains TRUE), a failure of the AI Command Input signal (value fails below 0%) causes the pressure output to decay to 0% of scale and remain there until a normal AI is received. Should the Guard Input go FALSE prior to the AI command failure, the last pressure output value will be held.

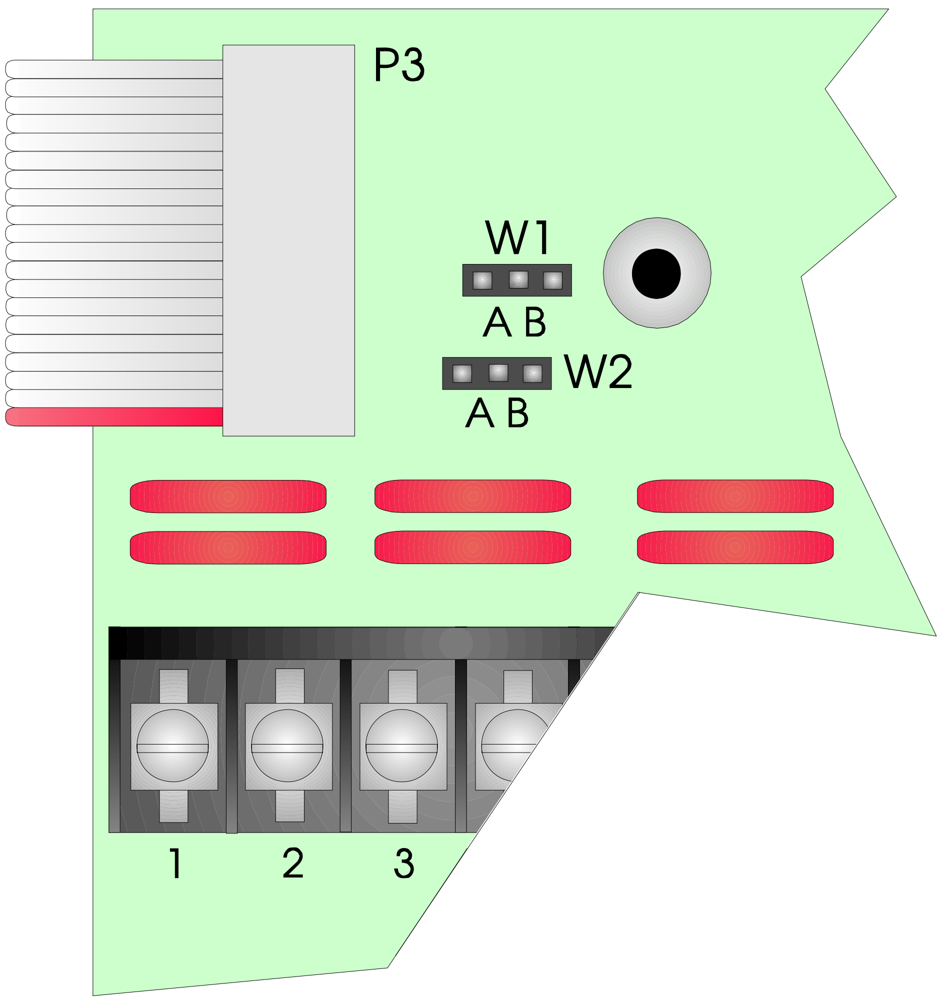


Figure 3-2 - Jumper Location on Analog Termination Board

Chapter 4
FIELD WIRING

4.1 GENERAL

This section illustrates and describes the field wiring terminals and various wiring configurations that apply to Analog, Raise/Lower, and Guard inputs, as well as the 4-20 mA current output and the dc power source. The wiring arrangements described herein are general and are not intended to cover every application.

4.2 TERMINAL BLOCK IDENTIFICATION

The Termination Board contains the field wiring terminals. Access to this board is obtained by removing the cover as described in Section 2 - Installation.

Two terminal blocks (TB1 & TB2) are located on the termination Board as shown in Figure 4-1. Each of these blocks contain six (6) terminal screws for field wiring connections. TB1 contains terminals TB1-1 through TB1-6, while TB2 contains TB2-1 through TB2-6.

The function of each terminal depends on whether the Regulator is an Analog or Raise/Lower model. The terminal designations for the Analog type are given in Table 4-1, while designations for the R/L types are given in Table 4-2.

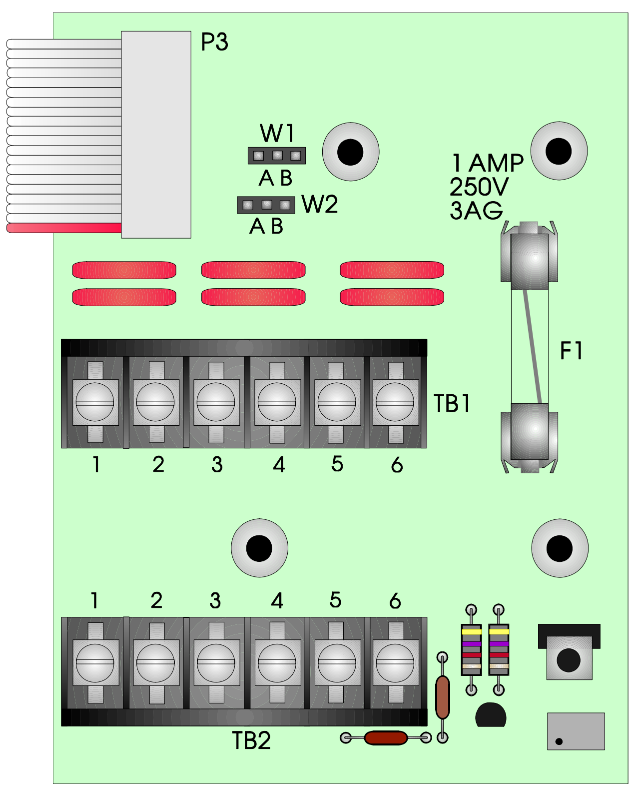


Figure 4-1 - Field Wiring Terminals

Table 4-1 - Terminal Identification For Analog Input Models

TERMINAL LEGEND	FUNCTION
TB1-1	Unused
TB1-2	Unused
TB1-3	Analog In+ (Command Input)
TB1-4	Analog In- (Command Input)
TB1-5	Guard
TB1-6	Guard Com
TB2-1	Unused
TB2-2	Current Out +
TB2-3	Current Out -
TB2-4	Supply +
TB2-5	Supply -
TB2-6	Unused
Green Screw	Chassis

Table 4-2 - Terminal Identification For Raise/Lower Models

TERMINAL LEGEND	FUNCTION
TB1-1	Raise (Command) Input)
TB1-2	Raise Com (Command) Input)
TB1-3	Lower (Command) Input)
TB1-4	Lower Com (Command) Input)
TB1-5	Guard +
TB1-6	Guard Com
TB2-1	Remote/Local Status
TB2-2	Current Out +
TB2-3	Current Out -
TB2-4	Supply +
TB2-5	Supply -
TB2-6	Unused
Green Screw	Chassis
Note: Raise, Lower & Guard Terminals are non-polarized and opto-isolated.	

4.3 ANALOG VOLTAGE INPUT (1-5 V) WITH GUARD

A voltage signal can be used as the Command Input as shown in Figure 4-2. In this example, a Bristol Babcock, METATONE B, Analog FSK Tone Receiver (Model 8772-31B) provides the input to the Remote Set Regulator. Switch SW2-8 must be set to the OPEN position to accommodate a 1-5 V input.

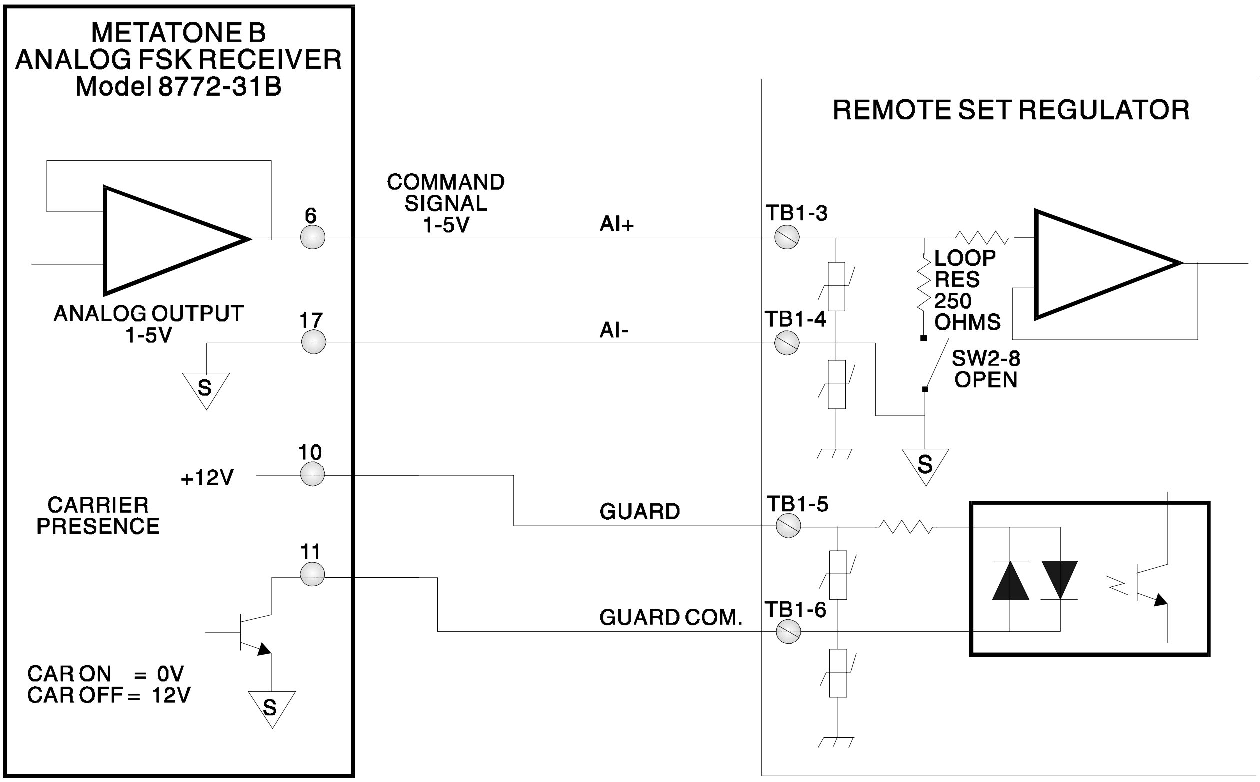


Figure 4-2 - Analog Voltage Input with Guard

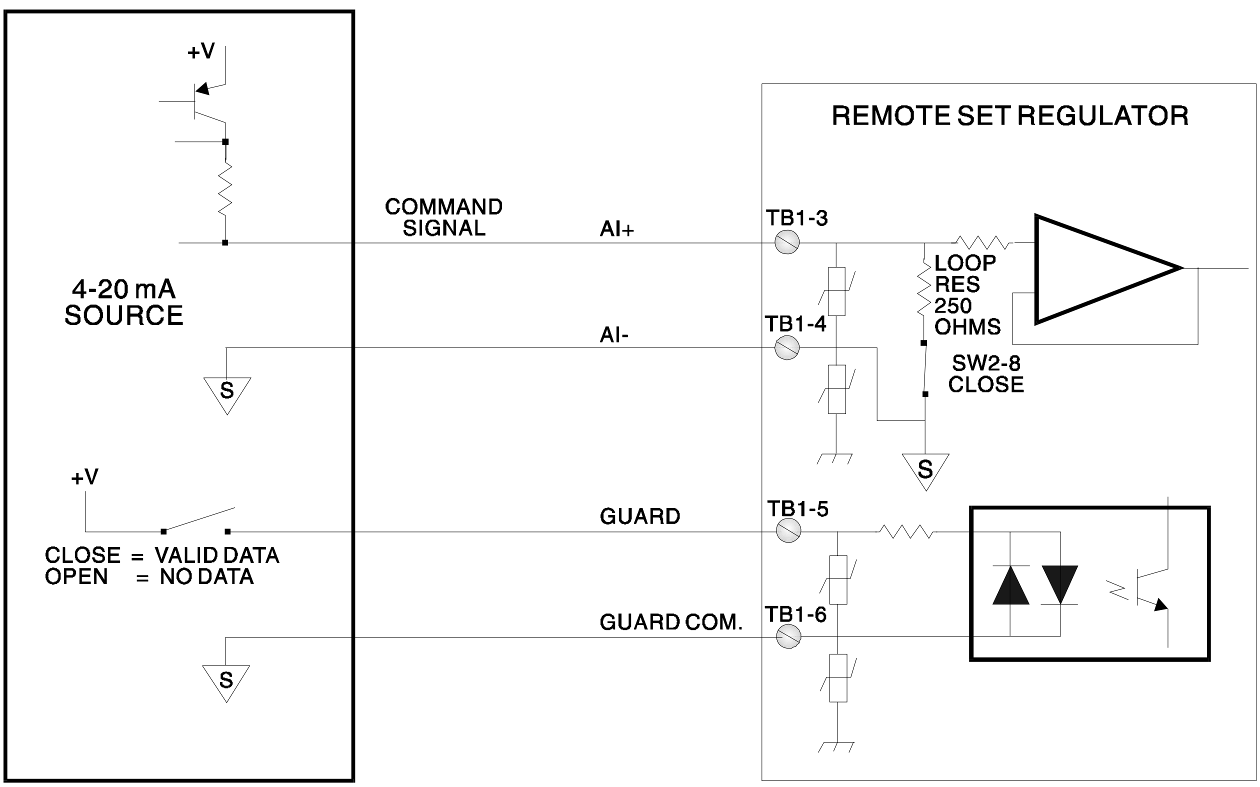


Figure 4-3 - Analog Current Input with Guard

For the application of Figure 4-2, the Carrier Presence output signal of the receiver may be connected to the Guard terminal as shown. Should the tone carrier fail, the Regulator will hold the last valid output value and prevent the Command Input from responding to extraneous signals.

4.4 ANALOG CURRENT INPUT (4-20 mA) WITH GUARD

In Figure 4-3, a 4-20 mA signal is obtained from the collector of an output transistor and wired to the input of the Regulator. Switch SW2-8 is set to the CLOSE position to bring the loop resistor into the circuit. The equivalent 1-5 volt drop across the 250 ohm loop resistor provides the Regulator input.

A switch or contact signal may be wired to the Guard Terminal as shown in Figure 4-3. This signal will be in an ON state when valid command data is sent and in an OFF state if the telemetry link opens.

The Guard signal may also emanate from an open collector circuit such as shown in Figure 4-2

4.5 RAISE/LOWER INPUTS WITH GUARD

The Raise and Lower inputs will accept either a continuous or incremental signal. A continuous signal is one that is held in a TRUE state to obtain a change of output pressure. An incremental signal is one that produces a step change of the output value for each TRUE input pulse that is received. Both types of inputs will maintain the last output value during the FALSE or failed states of the signal. The wiring illustrations described herein are applicable to either type.

The Guard input performs the same function as described under the previous analog subtopics. Since the Guard input is electrically identical to the Raise and Lower inputs, it can be wired in the same manner.

Figure 4-4 shows all inputs wired to external relay contacts or switches. Each contact is wired to a positive voltage source which must have the same value as the supply voltage required to power the Regulator (12 or 24 V type). When a contact is closed, the input is set ON (TRUE). When a contact is open, it is set OFF (FALSE).

The arrangement of Figure 4-5 receives all three inputs from a METATONE B FSK Tri-State Receiver. This receiver provides a MARK and SPACE output which connect to the respective Raise and Lower input terminals, and a CARRIER output that connects to the Guard terminal. The Receiver's tri-state outputs are provided as open collectors that drive the opto-isolated inputs of the Regulator. When any of the receiver's driver transistors conduct, the corresponding Regulator input will be set TRUE. When any driver transistor is cut off, the corresponding Regulator input will be set FALSE.

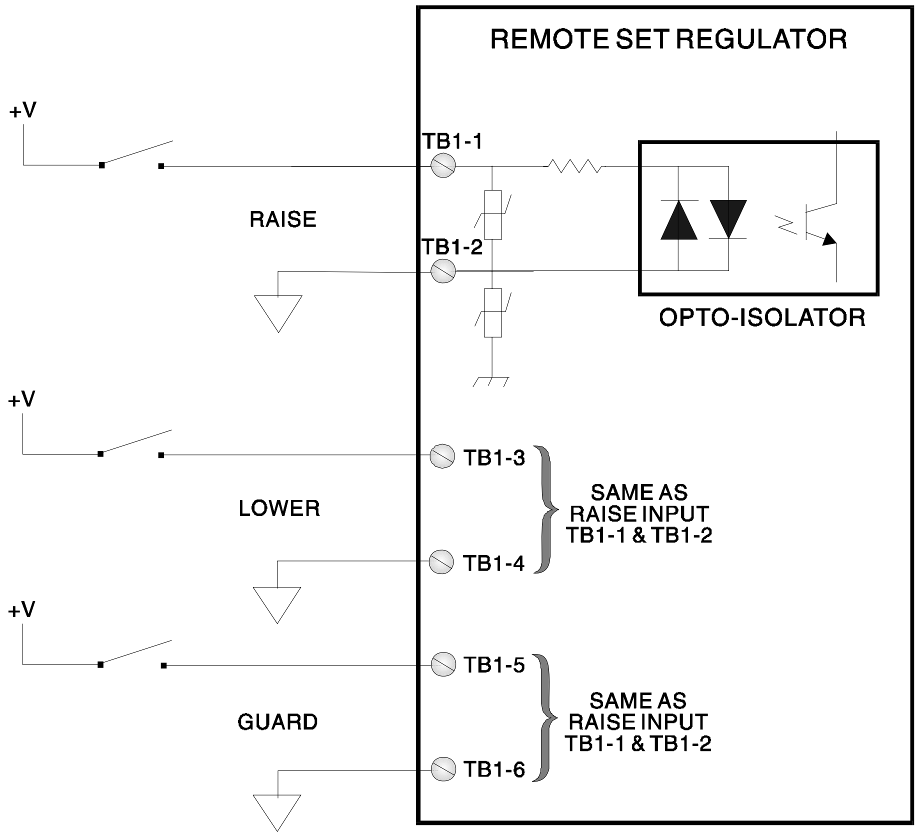


Figure 4-5 - Raise/Lower & Guard Inputs from Relay Contacts

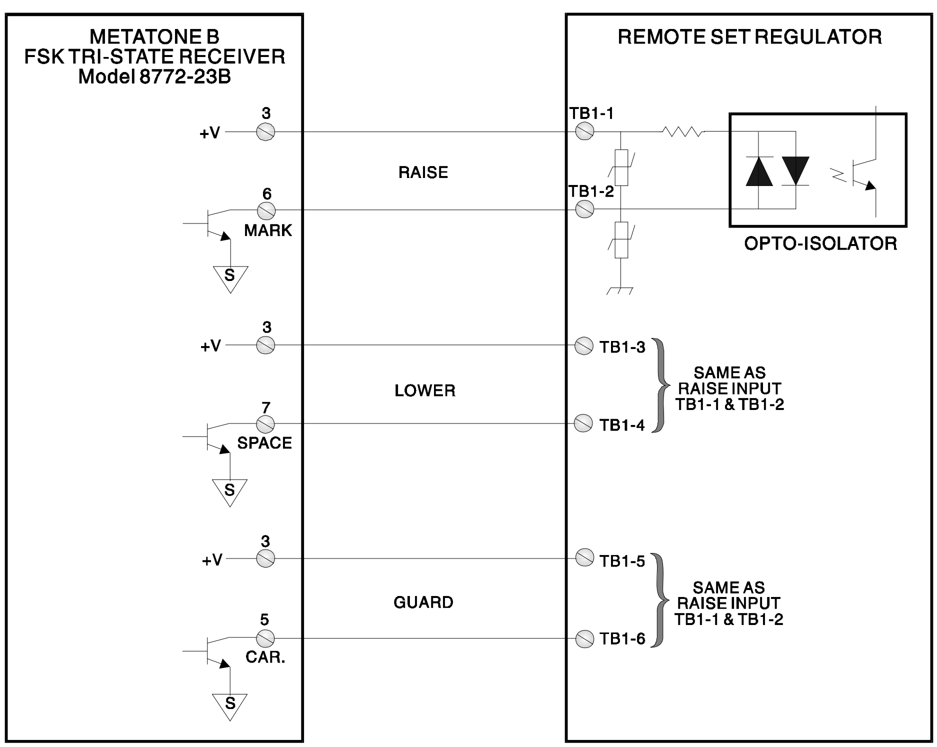


Figure 4-5 - Raise/Lower & Guard Inputs from Open Collectors

CAUTION

When using the Regulator with a device that provides latching type outputs (output stays ON until turned OFF), the Raise/Lower inputs must be set for a pulse incremental signal. (see Section 3 - Board Setup). This will prevent the Regulator from driving full scale should the telemetry line open while in the middle of a Raise or Lower command. By using this configuration, the pressure output value will only change when input pulses are received.

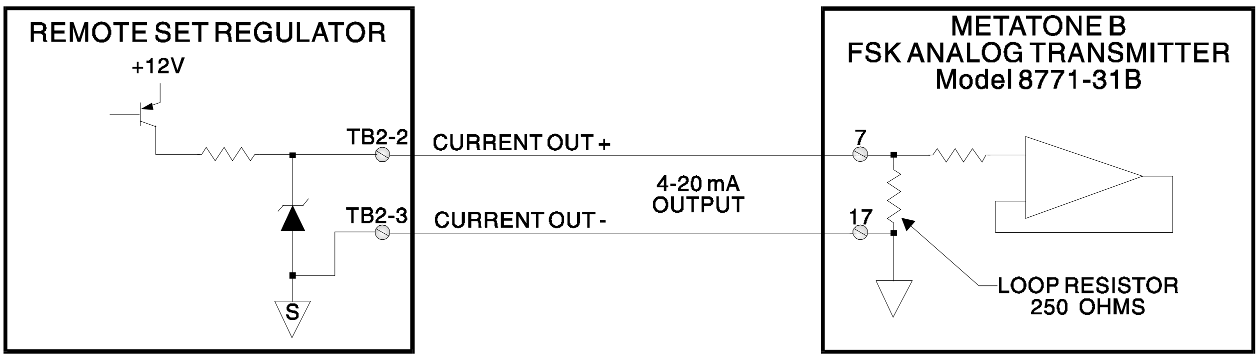


Figure 4-6 - Current Output to FSK Bi-State Transmitter

4.6 4-20 mA CURENT OUTPUT

The current output of the Regulator can be used to drive a METATONE B, FSK Analog Transmitter as shown in Figure 4-6. The 4-20 mA current signal is referenced to signal common and flows through the loop resistor present at the input of the Analog Transmitter. The current signal modulates a tone carrier which communicates with an Analog Tone Receiver at the command site (not shown).

4.7 DC POWER

The Remote set Regulator is factory-shipped for 12 or 24 Vdc supply operation. Before power is applied, a check should be made to ensure that the Regulator type matches the supply source.

The dc supply source is wired to the Regulator in Figure 4-7. An earth ground must be provided for both the Regulator housing and the supply. The connection for the Regulator is made to the green grounding screw located inside the housing (see Section 2 - Installation for illustration).

WARNING

Metal enclosures and exposed metal parts of all electrical instruments and devices must be grounded to prevent accidental electrical shock. Grounding must be in accordance with latest OSHA rules and regulations pertaining to "Design Safety Standards For Electrical Systems."

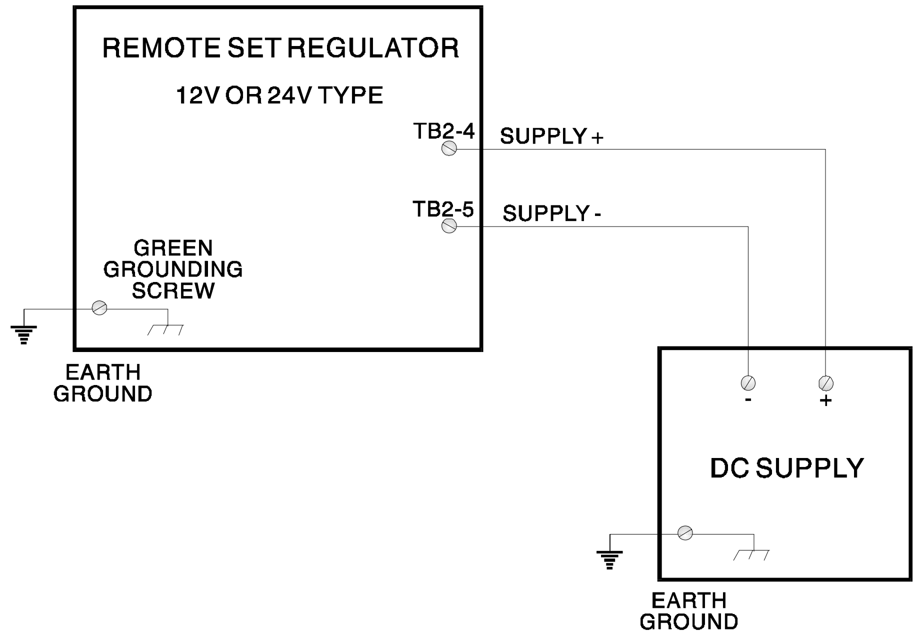


Figure 4-7 - DC Supply Connections

4.8 OPERATING NOTES

The startup procedures described herein are general for most applications. It is assumed that the user is familiar with all the external process devices such as shutoff valves, pressure limiters, circuit breakers, fuses, electrical supply, etc. and operates these devices in a manner that produces a safe startup. It is also assumed that the unit is properly wired and grounded as described in this section.

4.9 INITIAL CHECKS

Prior to starting the Regulator, its supply pressure and dc power source should be turned OFF. Also, the process associated with the Regulator should also be turned OFF or placed under some form of guarded control. A process that is not guarded may run out of control and cause property damage and injury to persons. Once these conditions have been met, proceed as follows:

1. The Regulator will be furnished as a 12 or 24 V dc type. Make sure that the supply voltage is correct for the Regulator.

2. Remote Set Regulators will be furnished with a 3-15, 3-27 or 6-30 psig output range. Check input pressure to the Regulator. It should be set to at least 3 psig above the upper range value, and not more than 100 psig. Pressures greater than 100 psig will require an external pressure limiter or regulator to maintain a safe input pressure.

3. To start the Remote Set Regulator, apply supply pressure and turn ON the dc power.

4. When power is applied, the stepper motor will operate immediately and set the output to a value that corresponds to the level of the Command input signal.

5. If the output pressure of the Remote Set Regulator fails to change even with a change at the Command input, the internal fuse may be blown. Check and replace it as required with a 1A, 250V 3AG type. If the fuse continues to blow, check for wiring mistakes at the field wiring terminals or check for a defective PC board. Do not attempt further operation until the problem has been resolved.

6. Once all the above checks have been completed, turn on the associated process and verify that the Regulator is operating properly. Startup is complete.

Chapter 5
SERVICE

5.1 GENERAL

The servicing and calibration procedures described in this section should only be performed by qualified technical personnel.

These procedures should not be performed while the Remote Set Regulator is connected to an on-line process. A laboratory setup is recommended for calibration and servicing. If this is not possible, steps should be taken to close down the process or to isolate the Regulator in such a manner that it has no control over the process.

**** Warning ****

Models intended for operation in hazardous areas require additional precautions. Under no circumstances should the cover be removed while the instrument is powered and operating. If access is required, either the dc power must be turned off, or the environment must be made safe, i.e., non-hazardous. An electrical spark in a hazardous environment could cause fire or an explosion and result in property damage and injury to persons.

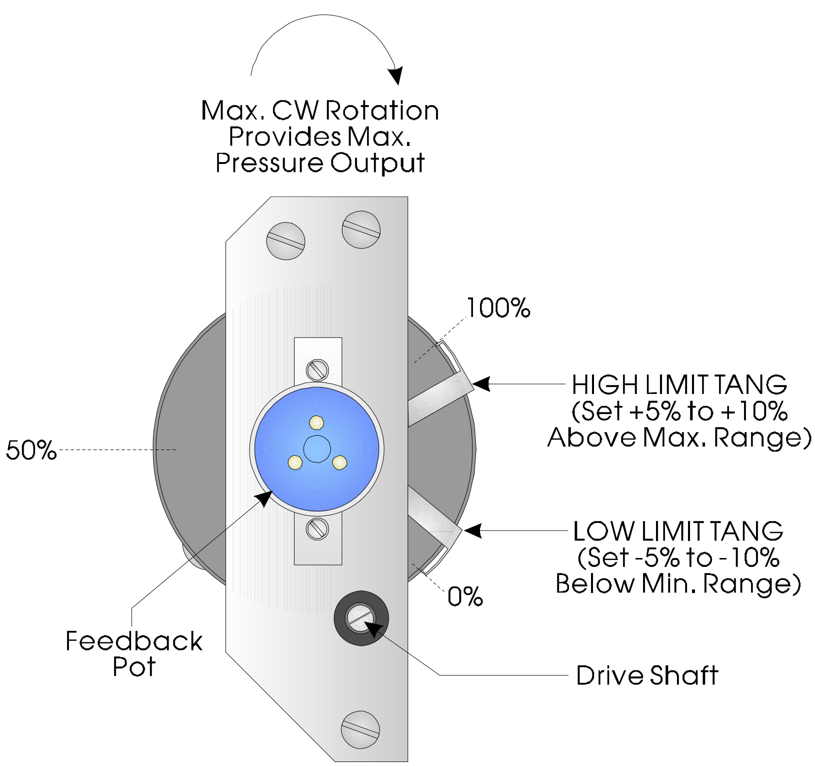


Figure 5-1 - Rear View of Gear Drive Assembly

5.2 TROUBLESHOOTING HINTS

Some basic types of problems that can occur in the field are listed as follows:

○ **Unit dead, no motor movement**

Measure across power terminals TB2-4 & -5 with a DVM. The reading should be 12 or 24 V dc depending upon model. Incorrect or no voltage indicates an external supply problem. If proper voltage is present, check Fuse F1 on the Termination Board. Fuse F1 should be a 1A, 250 V, 3AG type. If replacement fuses continue to blow, a short may be present at the field wiring terminals or in the PC boards.

○ **Output drift on Analog model**

Check for open signal lead at input terminals TB1-2 & -3. Measure across terminals with a DVM and check for proper voltage range.

○ **Output stays constant with input change**

If Guard mode is used, check for proper signal at Guard terminals TB1-5 & -5. If Guard is not used, make sure SW2-6 is in the CLOSE position.

○ **Severe output tracking errors on Analog model**

Check setting of switches SW1 (1-5). If any are set to Pulse Increment mode, the output will not balance properly. These switches must be set OPEN for Analog models.

○ **Noisy or Erratic Output on Raise Lower Model**

Try SW1-8 in both positions and choose the one with the lowest noise level. For Analog models, this switch must be set OPEN.

○ **Raise or Lower function does not work on Raise/Lower model**

Check voltage at Raise or Lower terminals TB1 (1-4) with voltmeter during activation. Also check across Guard terminals TB1-5 & -6, if used. If no voltage change occurs at any given input, check for broken signal leads or a defect in the external device.

○ **Output pressure does not rise above certain point**

A high limit may be set too low or the pressure regulator vent may be restricted. Also check for water or oil in pressure lines.

○ **Output pressure drops off with constant level input**

Check for leaks in pressure lines or loose fittings.

5.3 SETTING OUTPUT LIMITS

5.3.1 General Principles

The Regulator provides mechanical output limits that prevent the output from underranging or overranging the process. When the Command Input is of a value that causes the stepper motor to drive against a limit, the clutch will allow the driveshaft to slip. After the motor has completed several revolutions, the software will turn it OFF to prevent clutch wear. The motor will remain OFF until the Command Input signal returns to a value that is within the set limits.

5.3.2 Test Setup

When a Remote Set Regulator leaves the factory, the low limit is set to about -10% below the minimum range value, and +10% above the high range value. These limits may be changed in the field if the user has the capability to adjust the dc input signal over the full range of the Regulator and to monitor the pressure output. Bench calibration setups similar to that shown in Figures 5-2 or 5-3 may be used to set the mechanical limits on Analog or Raise/Lower models. The DMMs (digital multimeters) shown in both illustrations are not required for setting limits.

5.3.3 Procedure

The method of setting the mechanical Hi and Lo Limit adjustments are described as follows:

1. Check that pressure supply to Remote Set Regulator is at proper value. Turn off dc power source (12 or 24 V dc) to Remote Set Regulator and remove Regulator Cover.

2. For all models, set switch SW2-6 to CLOSE to disable the Guard input.

3. For Analog models, set jumpers W1 and W2 for Fail/Hold mode. See Section 3, Board Setup. Turn ON dc power source.

4. Locate two limit adjustment tangs on main gear assembly. Refer to Figure 5-1.

5. Adjust dc test input level to approximately -20% below minimum range value. Pressure output will fall to a minimum value and remain there.

6. If limit tangs were previously set at factory their positions on main gear will appear about as shown in Figure 5-1. If tangs are at different positions, other limit values may have been field-selected.

7. Turn off dc power. Limits are set by estimating positions on main gear assembly. To set a limit, slightly lift edge of tang from teeth of main gear and carefully move tang to approximate desired position. Release tang to lock its position. If access to a tang is blocked, re-apply dc power and adjust dc input level to a value that will rotate main gear in a direction to make tang accessible. Turn off dc power and set limits as required.

8. Once limits have been set, re-apply dc power and adjust input test circuit (analog or raise/lower) for range value above upper limit. When upper limit is reached, main gear will stop rotating and output pressure will hold constant at value of desired limit.

**** Caution ****

Do not attempt to turn main gear or driveshaft by hand to reach a limit. The force generated in this manner can easily damage the gear teeth and limit tangs. Always use a dc test input signal to drive the main gear through its range.

9. If limit values are not at desired points, continue to experiment with tangs until correct positions can be found.

10. When adjustments are complete, disconnect test setup and recheck board configuration as required. Replace cover and restore unit to normal operating status.

5.4 CALIBRATION TEST SETUP

The calibration of the Remote Set Regulator will require a laboratory bench setup. The setup of Figure 5-2 is used for Analog models, while that of Figure 5-3 is used for Raise/Lower models.

In Figure 5-2, the Analog model uses a precision 1 - 5 volt test source to provide an adjustable input signal. In Figure 5-3, the Raise/Lower model uses a switch test circuit consisting of two pushbutton switches that apply dc power to either the Raise or Lower inputs. As long as a switch is pressed, the output will be raised or lowered assuming continuous dc input configuration.

From this point on, the test setups of Figures 5-2 and 5-3 are identical. A digital multimeter (DMM #1) is connected across test points TP3 and TP4 to monitor the voltage at the center arm of the feedback potentiometer. The 250 ohm resistor and switch circuit is used to load the current output circuit, while DMM #2,functioning as a milliammeter, measures the load current.

On the pneumatic side, a constant supply pressure is applied to the pressure regulator assembly. A precision test gauge monitors the pressure output signal. The pressure regulator assembly of the unit does not have calibration adjustments. All adjustments are electrical.

5.5 CALIBRATION PRECAUTION

During calibration, the stepper motor will be driven to both ends of it operating range. Since this movement is extremely slow, do not be tempted to run the unit up or down range by manually forcing the main gear or driveshaft. Doing so can cause damage to the gear teeth and the mechanical limit tangs. Always use a dc test input signal to reposition the main gear and allow the Remote Set Regulator to balance itself out.

5.6 PRELIMINARY CALIBRATION CHECK

Once the test setup of Figure 5-2 or 5-3 has been completed, the following conditions must be established.

1. For all models, set switches SW1 (1-5) to OPEN for continuous operation, and SW2-6 to OPEN to disable Guard circuit. For Analog models only, set SW2-8 to OPEN for 1 - 5 V input.

2. Determine the output range of the Regulator (3-15, 3-27 or 6-30 psi). See if it is possible to scan the complete range of the regulator by adjusting the input test circuit and observing the pressure test gauge. If range of travel is not complete, mechanical limits are less than output span or:

   0% < Limits < 100%

   At this time, position limits to following settings (see topic 5.3):

   Lo Limit = -10% (approximately)
   Hi Limit = +110% (approximately)

   If full range cannot be obtained even with above limits, other problems may be indicated. Refer to topic 5.2 for troubleshooting hints before proceeding.

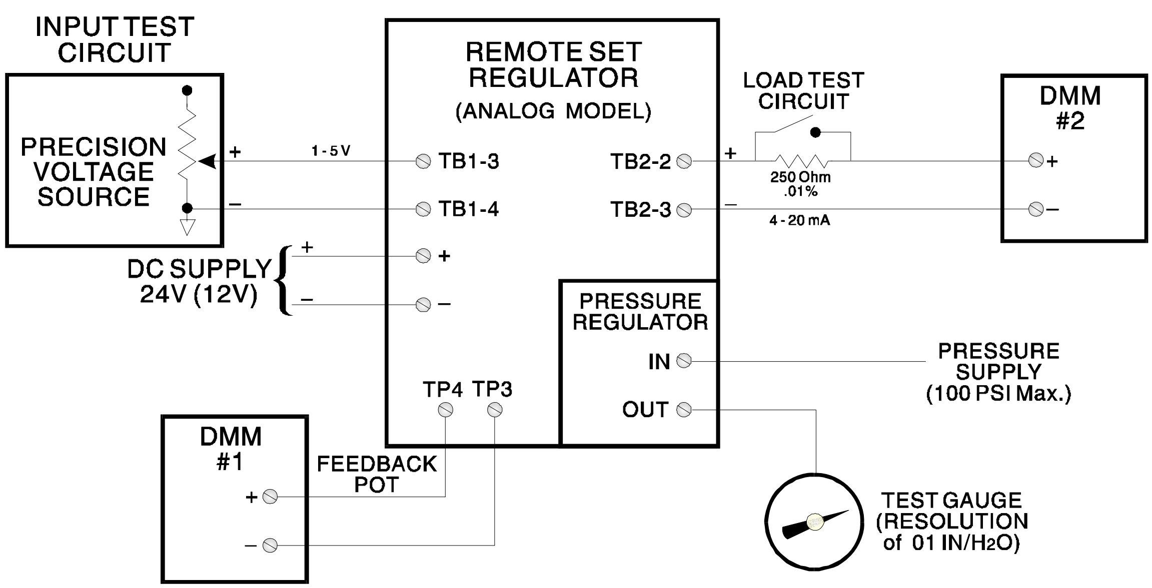


Figure 5-2 - Analog Test Setup

3. Set input test circuit for 0.995 V reading on DMM #1. DMM #2 should read 4 mA, ±.02 mA Test gauge should read minimum range value (3 or 6 psi), ±5.0%.

4. Press input test circuit push-buttons for 4.995 V, ±0.004 V reading on DMM #1. Reading on DMM #2 should be 20 mA, ±.02 mA. Test gauge should read maximum output range value (15, 27 or 30 psi), ±5.0%.

5. If above readings are within stated specifications, stop! No calibration is required. Restore instrument to normal operation. Otherwise, proceed to topic 5.7 or 5.8 as required.

5.7 DETAILED CALIBRATION FOR ANALOG MODEL

If calibration errors were found in topic 5.6, the procedures described here for Analog models are performed.

5.7.1 Feedback Zero & Span

Precision voltage of an input test circuit is used to calibrate the zero and span as follows:

1. Adjust input test circuit for 1.000 V output.

2. DMM #1 should read 0.995 V, ±.004 V.

3. If reading of step 2 is out of tolerance, slightly loosen two screws on body of feedback pot (Figure 5-1) and rotate body until DMM #1 reads as specified in step 2. Secure pot screws to lock in setting.

4. Adjust the input test circuit for 5.000 V.

5. DMM #1 should read 4.995 V, ±.004 V

6. If the reading of step 5 is out of tolerance, adjust potentiometer R35 on CPU to correct.

7. Recheck both points and readjust zero and span if required.

5.7.2 Current Output Span & Load

The current output circuitry is provided with two calibration adjustments. Potentiometer R50 is used for span adjustment and R49 for load compensation. For these tests, DMM #2 (used as a milliammeter) is connected in series with a 250 ohm load resistor as shown in Figure 5-2. The pushbutton switch is used for load testing.

1. Adjust input test circuit for 5.000 V.

2. DMM #2 should read 20 mA, ±.02 mA. If necessary, adjust pot R50 to correct.

3. Press load pushbutton while observing DMM #2. If current reading increases, adjust R49 CCW. If reading decreases, turn it CW. Repeat procedure until change is less than ±.02 mA.

4. Final reading should be 20 mA, ±.02 mA. If necessary, reset pot R50 and repeat the procedure.

5.7.3 Pressure Output Check

1. Adjust input test circuit for 1.000 V.

2. Reading on test gauge should be minimum range value (3 or 6 psi), ±5%.

3. Adjust input test circuit for 5.000 V.

4. Reading on test gauge should be maximum range value (15, 27 or 30 psi), ±5%.

5. If electronic calibration is correct but output pressure is in error, no further adjustments are possible. Refer to topic 5.2 for possible pneumatic faults.

6. Calibration is complete. Restore unit to normal operation.

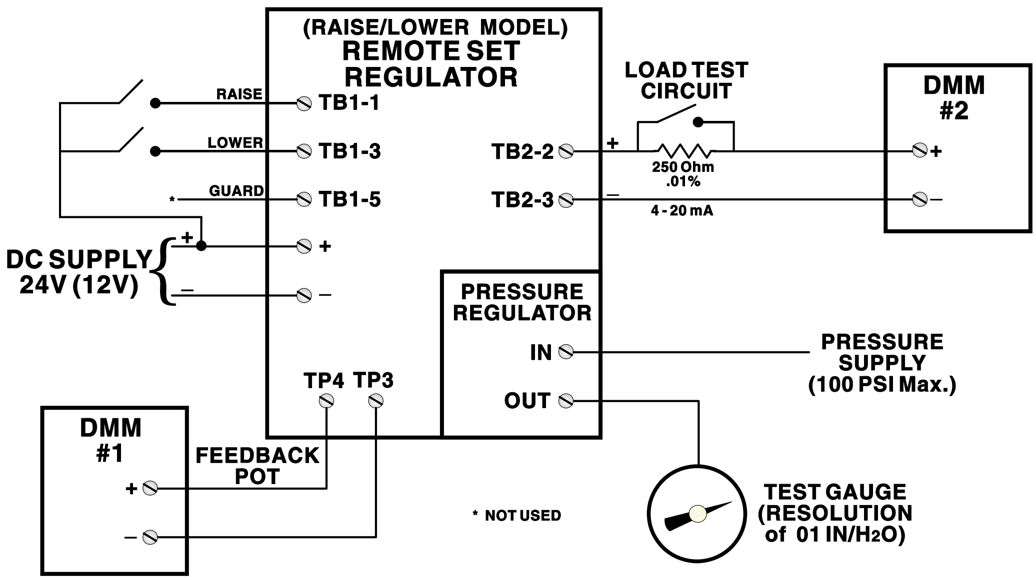


Figure 5-3 - Raise/Lower Test Setup

5.8 DETAILED CALIBRATION FOR RAISE/LOWER MODEL

If calibration errors were found using the procedures of topic 5.6, the procedures described herein for Raise/Lower models are performed.

5.8.1 Feedback Zero & Span

The tracking voltage provided by the motor-driven feedback potentiometer is calibrated against the pressure output as follows:

1. Adjust input test circuit for minimum range indication on test gauge (3 or 6 psi).

2. DMM #1 should read 0.995 V, ±.004.

3. If reading of step 2 is out of tolerance, slightly loosen two screws on body of feedback pot (Figure 5-1) and rotate body until DMM #1 reads as specified in step 2. Secure pot screws to lock in setting.

4. Adjust input test circuit for maximum range indication on test gauge (15, 27 or 30 psi).

5. DMM #1 should read 4.995 V, ±.01 V

6. If the reading of step 5 is out of tolerance, adjust potentiometer R35 on CPU Board to correct.

7. Recheck both points and readjust if required.

5.8.2 Current Output Span & Load

The current output circuitry is provided with two calibration adjustments. Potentiometer R50 is used for span adjustment and R49 for load compensation. For these tests DMM #2 using the current measurement function is connected in series with a 250 ohm resistor load as shown in Figure 5-3. The pushbutton switch is used to jump the load.

1. Adjust input test circuit for 4.995 V on DMM #1.

2. DMM #2 should read 20 mA. If necessary, adjust pot R50 to correct.

3. Press load pushbutton while observing DMM #2. If current reading increases, adjust R49 CCW. If reading decreases, turn it CW. Repeat procedure until change is less than ±.02 mA.

4. Final reading should be 20 mA, ±.02 mA. If necessary, reset pot R50 and repeat procedure.

5. Calibration is complete. Restore unit to normal operating status.

5.9 PCB REFERENCE DRAWINGS

Table 5-1 below provides part numbers and drawing references (Figures 5-4 through 5-7) for the printed circuit boards provided with the Remote Set Regulator.

Table 5-1 - CPU Board & Termination Board Reference Table

Fig.	Assembly	Part #	Page
5-4	Assembly, Analog Type CPU Board w/ Current Output (12V)	389615-03-0	5-9
5-4	Assembly, Analog Type CPU Board w/ Current Output (24V)	389615-06-4	5-9
5-5	Assembly, Analog Termination Board	389644-01-3	5-9
5-6	Assembly, Raise/Lower Type CPU Board w/ Current Output (12V)	389613-03-7	5-10
5-6	Assembly, Raise/Lower Type CPU Board w/ Current Output (24V)	389613-06-1	5-10
5-7	Assembly, Raise/Lower Termination Board	389616-01-0	5-10

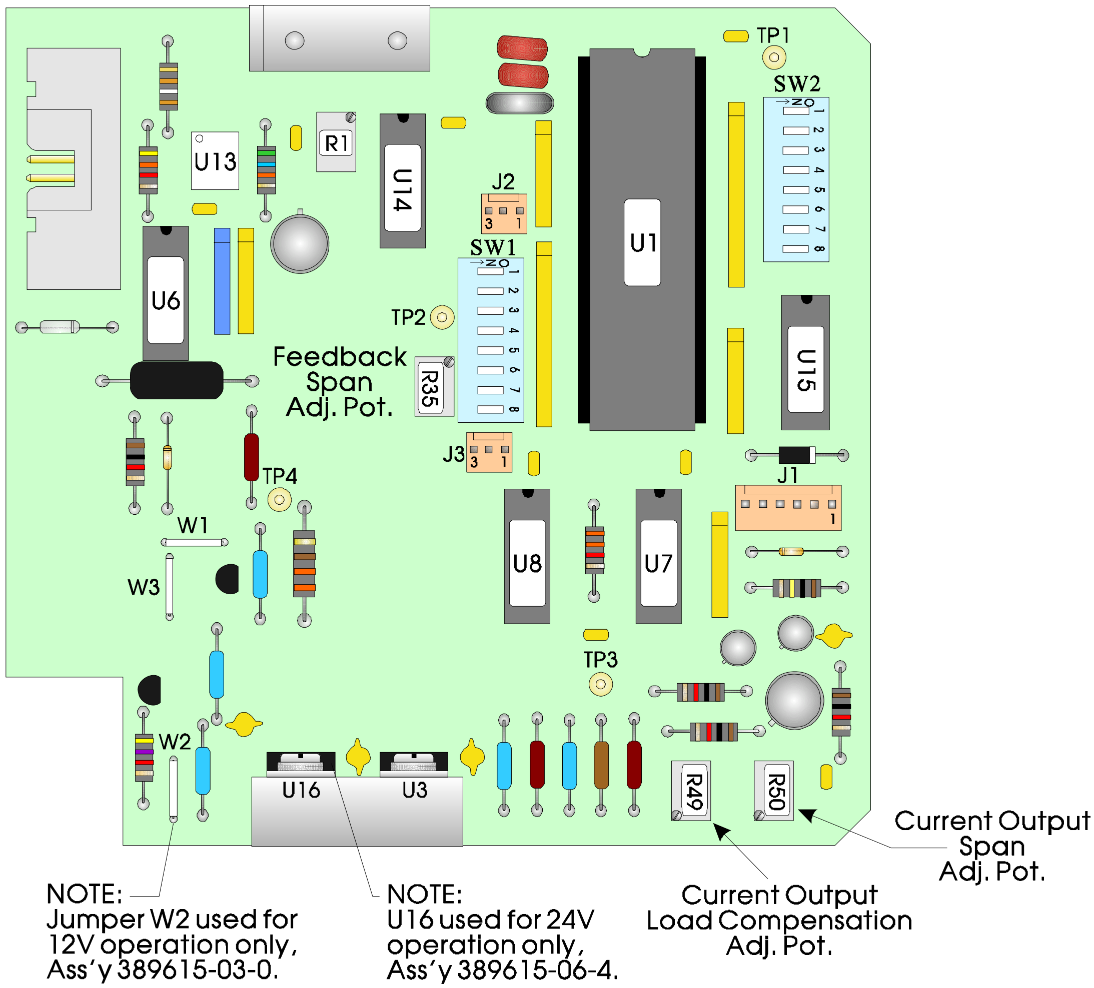


Figure 5-4 - Assembly, Analog Type CPU Board with Current Output

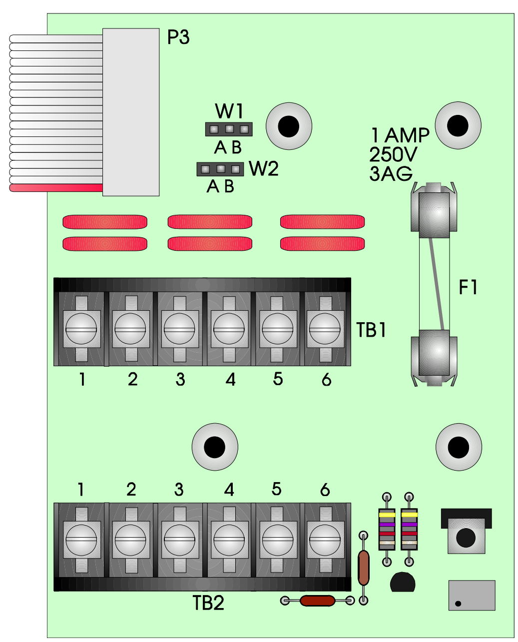


Figure 5-5 - Assembly, Analog Termination Board

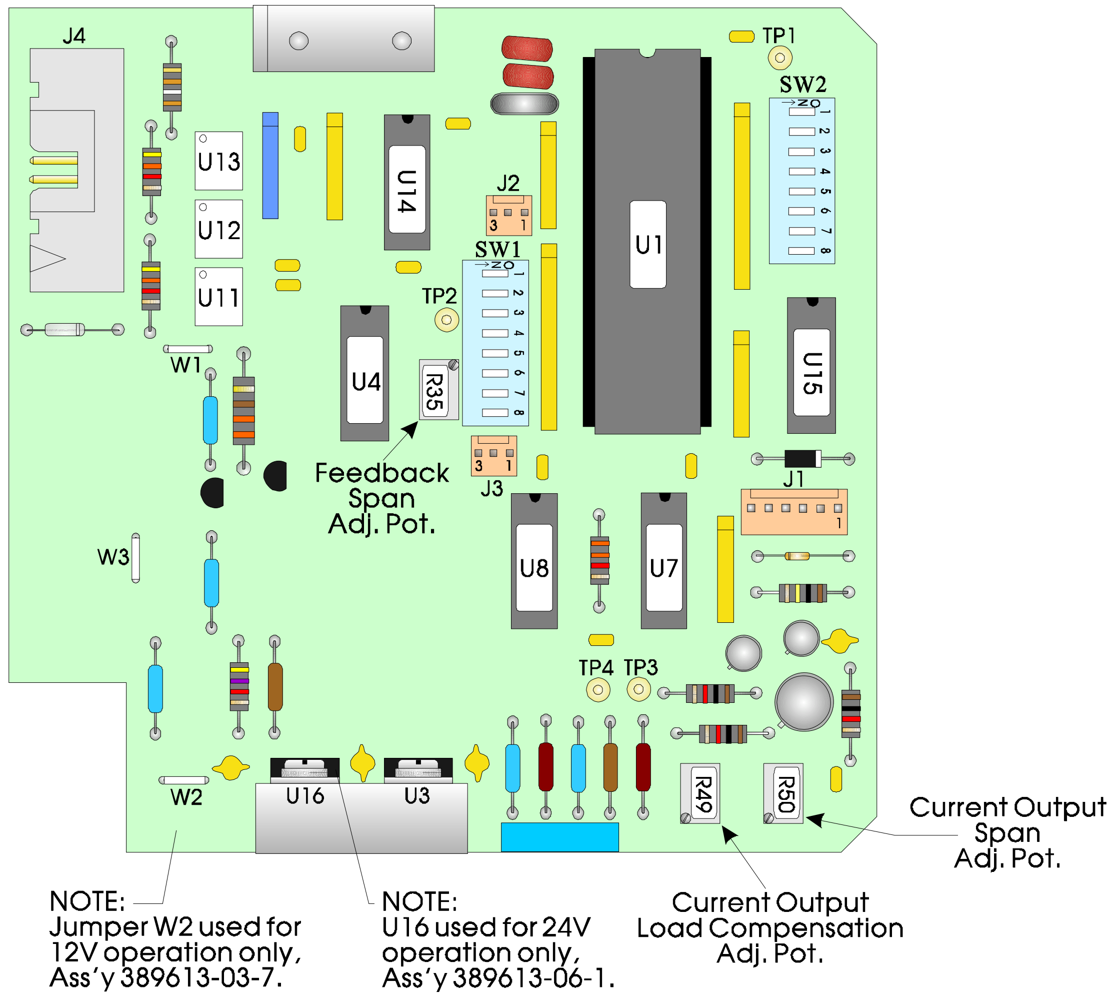


Figure 5-6 - Assembly, Raise/Lower Type CPU Board with Current Output

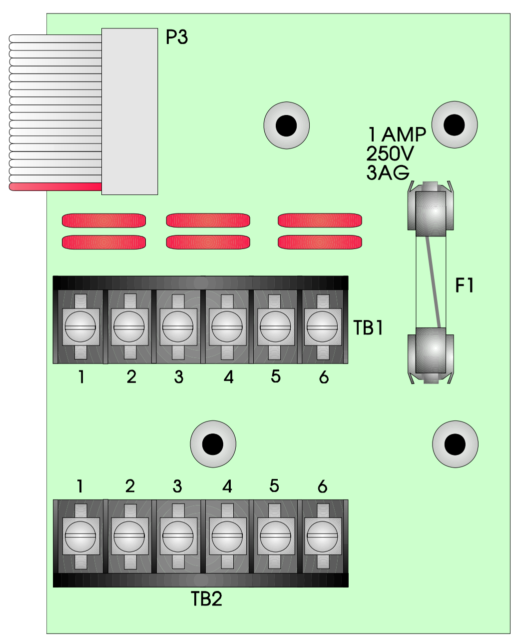


Figure 5-7 - Assembly, Raise/Lower Termination Board

Chapter 6
SPECIFICATIONS

6.1 ANALOG INPUT MODEL

Function:	Uses Analog Input to set a pressure output signal.
Ranges:	4 - 20 mA dc or 1 - 5 Vdc
Input Impedance:	For 1 - 5 V > 330 K Ohms For 4 - 20 mA > 250 Ohms, ±0.1%
Analog Fault Detector:	Stepper Motor is cut off when AI < 0.8 V, ±0.1V

6.2 RAISE/LOWER INPUT MODEL

Function:	Uses Raise and Lower Inputs to set a pressure output signal. Input may be configured to accept a continuous ON/OFF dc signal or incrementing dc pulse signal.
Input Characteristics:	Opto-isolated and bi-polar. Limited to 47 V by metal oxide varistor (MOV).
Types of Inputs Accepted:	May be configured for continuous dc input signal (On or Off) or dc pulse incrementing signal.
Continuous DC Input:	Maximum dc input level is a function of the supply voltage as follows: 12V Model: 11 - 14 Vdc 24V Model: 22 - 28 Vdc
DC Pulse Incrementing Input:	Pulse rates adjustable from 0.110%/pulse to 1.830%/pulse. Pulse must be held in TRUE state for time period necessary for Regulator to reach the new output value. An input that changes state before completion of an operation will have its remaining pulse increment discarded. The next complete pulse starts a new increment.
Input Impedance:	For 12V Model: 1800 Ohms For 24V Model: 4300 Ohms

6.3 GUARD INPUT

Enables or inhibits command signal input on both Analog and raise/Lower models.

6.4 ANALOG OUTPUT

Function:	Current feedback signal tracks the output of the Remote Set Regulator. Signal is typically used to telemeter pressure output value back to the command site.
Range:	4 - 20 mA common ground type output
Load Resistance:	380 Ohms Max.

6.5 ACCURACY - ANALOG MODELS

Electrical Input to Pressure Output:	±5% of span
Pressure output to Feedback:	±5% of span

6.6 ACCURACY - RAISE/LOWER MODELS

Feedback Volts to Pressure Output:	±5% of span
Pulse Input to Pressure Output:	±20% of span

6.7 DC POWER

12 Volt Model:	11 - 14 Vdc @ 0.35 A Max.
24 Volt Model:	22 - 28 Vdc @ 0.25 A Max.
Fuse:	1 A, 250 Vdc, 3AG

6.8 STEPPER DRIVE MECHANISM

Stepper Motor:	Gearing from motor shaft to pressure regulator assembly results in approximately 22,000 incremental steps for 100% output range travel.
Output Rate of Change:	Full scale sweep adjustable from 1.8 to 69.4 minutes.
Environmental Effects:	±1.0% Max. full scale per 50°F (28°C)
Supply Voltage Effect:	±0.15% Max. full scale per 1 volt change

Hysteresis:	(Output to gauge) 0.5% of span
Motor Protection:	Adjustable mechanism limits restrict output for over and under range conditions. Automatic timeout prevents clutch wear.
Power Failure:	Mechanism maintains output pressure prior to loss or drop of supply voltage.

6.9 PRESSURE REGULATOR ASSEMBLY

Output Ranges Offered:

Range	Factory Calibrated with
3 - 15 psig	20 psig supply
3 - 27 psig	30 psig supply
6 - 30 psig	35 psig supply

Supply Pressure Range:

Type Unit (psig)	Min. Supply (psig)	Max. Supply (psig)
3 - 15	20	100
3 - 27	30	100
6 - 30	35	100

Supply Pressure Effect:	0.1 psig Max. change in output for each 10 psig change of input.
Connection:	IN, OUT and VENT ports (1/4 Inch NPT)

6.10 INSTRUMENT ENCLOSURE

Type of Case:	Weatherproof and explosion proof. Cast aluminum with gasketed screw-on cover. Gray epoxy finish. Meets NEMA-3 specifications
General Dimensions:	6 inch (152.4 mm) diameter 7 inch (176.8 mm) length
Weight:	10 pounds (4.54 kg)
Mounting Options:	In-line pressure pipe or 2 inch pipe bracket

6.11 ENVIRONMENTAL

Temperature Limits:	-20° to +150° F (-29° to +65° C) Operating -40° to +185° F (-40° to +85° C) Storage

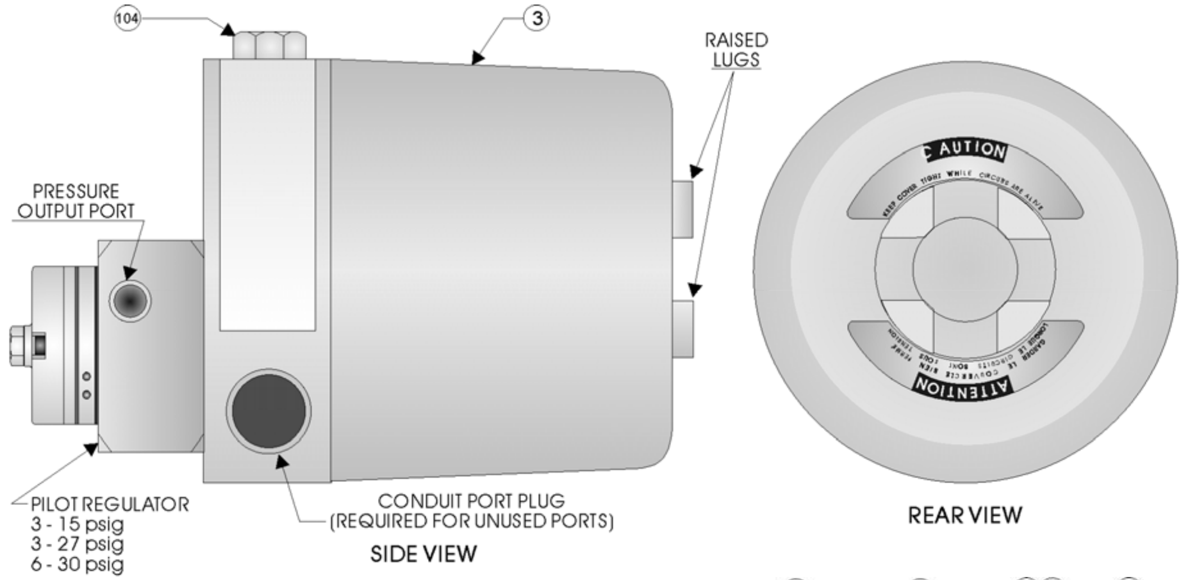
Humidity:	10 to 95% over -20° to +130° F (-29° to +55° C) range 10 to 50% over +130° to +150° F (+55° to +65° C) range
Vibration Limits:	0.1 gram Max. over 10 to 500 Hz range
RFI Rejection:	Per SAMA standard PMC 33.1, Class 1 and 2, 20 MHz to 500 MHz. Rejection is greater than 0.5% full scale error.

Chapter 7
PARTS

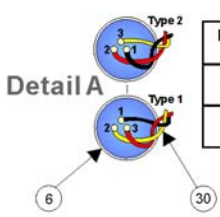
7.1 MODEL 9110 MAIN PARTS

Parts Referenced in Figure 7-1

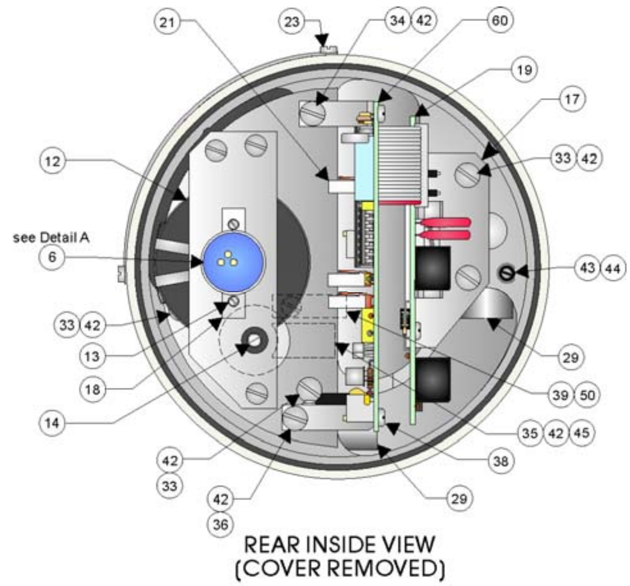
Item	Description	Part Number
1	Housing	390701-01-7
2	O-Ring, Size – 161	316135-12-7
3	Remove Setpoint Cover	389385-02-6
4	Motor Support Assembly	390724-01-7
5	Clutch Assembly	390692-01-8
6	Potentiometer	390739-01-4
7	Socket Head Screw, 6-40 x 1/8	282403-00-0
8	Right Hand Stop	390736-02-3
9	Left Hand Stop	390736-01-5
10	Shaft & Pot. Support Assembly	390723-01-0
11	Shoulder Screw, 10-32 x 1-3/16	390726-01-0
12	Gear, 144 Teeth, 63 Pitch	390684-01-5
13	Screw, 2-64 x 3/16 FH	237603-00-4
14	Shaft Assembly	396405-01-0
15	Sleeve, Output Shaft	390695-01-7
16	Motor Assembly:	
	12 V dc type	390738-01-8
	24 V dc type	390738-02-6
17	Bracket, Terminal Block	390080-01-2
18	Clamp, Pot.	390090-01-8
19	PC Board Assembly, 624-II Remote Raise/Lower Termination Board:	
	12 & 24 Vdc Discrete Input Versions	389616-01-0
	12 & 24 Vdc Analog Input Version	389644-01-3
20	Gear, 68 Teeth, 64 Pitch	390735-01-9
21	Jumper, Remote Regulator	390761-01-0
23	Screw, 4-40 x 3/1 Pan Head	374600-03-1
24	Cable Tie, Self Clinching (Not Shown)	308708-00-8
29	Bushing, 3/4" ID Wire	390104-01-9
30	Cable, Pot.	390404-01-2
33	Screw, 10-32 x 3/8 PH	374602-06-9
34	Screw, 10-32 x 1/2 PH	374602-08-5
35	Screw, 10-32 x 3/4 PH	374602-12-3
36	Screw, 10-32 x 1-1/2 PH	374602-24-7
38	Screw, 6-32 x 3/16 PH	374601-03-8
39	Screw, 6-32 x 5/16 PH	374287-01-5
42	Lockwasher, #10	235638-00-5
43	Screw, 8-32 x 5/16 HH	374616-01-9
44	Cup Washer, #8	387445-01-3



Item 6 to Item 30 Wire Connections



POTENTIOMETER Type	Black	Red	Yellow
Type 2	Pin 1	Pin 2	Pin 3
Type 1	Pin 1	Pin 3	Pin 2



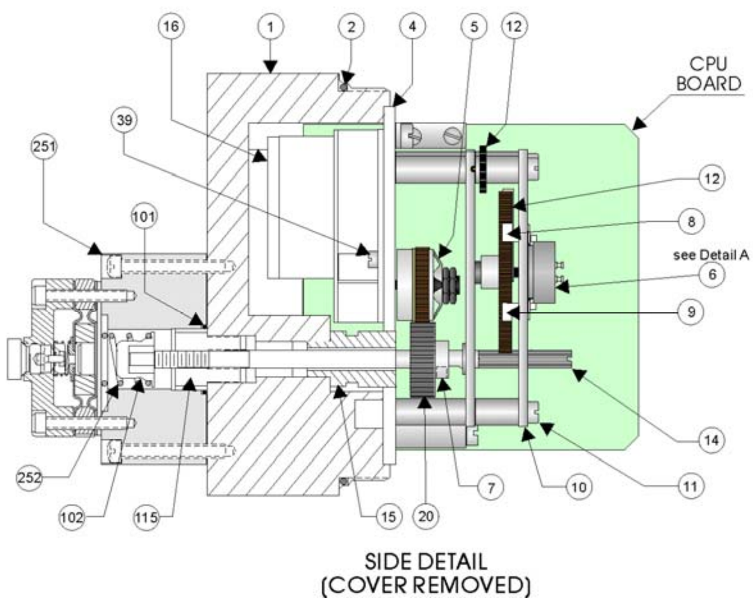


Figure 7-1 – Remote Set Regulator Actuator Unit

Parts Referenced in Figure 7-1 (Continued)

Item	Description	Part Number
45	Clamp, Sleeve	390102-01-6
50	#4 Cable Clip	295379-00-6
60	CPU Board Type	(see below):

Type	Supply	Output	Part Number
Analog (AI)	12 V	Current	398615-03-0
Analog (AI)	24 V	Current	389615-06-4
Raise/Lower (DI)	12 V	Current	389613-03-7
Raise/Lower (DI)	24 V	Current	389613-06-1

Item	Description	Part Number
101	O-Ring, .864 ID x .070 W	317303-08-2
102	Seat, Spring	396404-01-4
104	Plug, ¾ N.P.T. Hex Socket	379891-05-0
115	Bushing, Regulator Shaft	396403-01-8
251	Regulator	390737-
252	Spring, 3-15 psig Range	390737-01-1
	Spring, 3-27 & 6-30 psig Range	390737-02-0

Parts Referenced in Figure 7-2

Item	Description	Part Number
103	Screw, 10-32 x 1-1/2 SHCS	396400-02-7
201	Bracket, Mounting	390190-01-2
202	Screw 1/4-20 x 1/2” Hex Head	379496-02-0
203	1/4" Lockwasher	234918-00-4
204	Clamp Assembly	388931-01-9
205	5/16” Lockwasher	277992-00-1

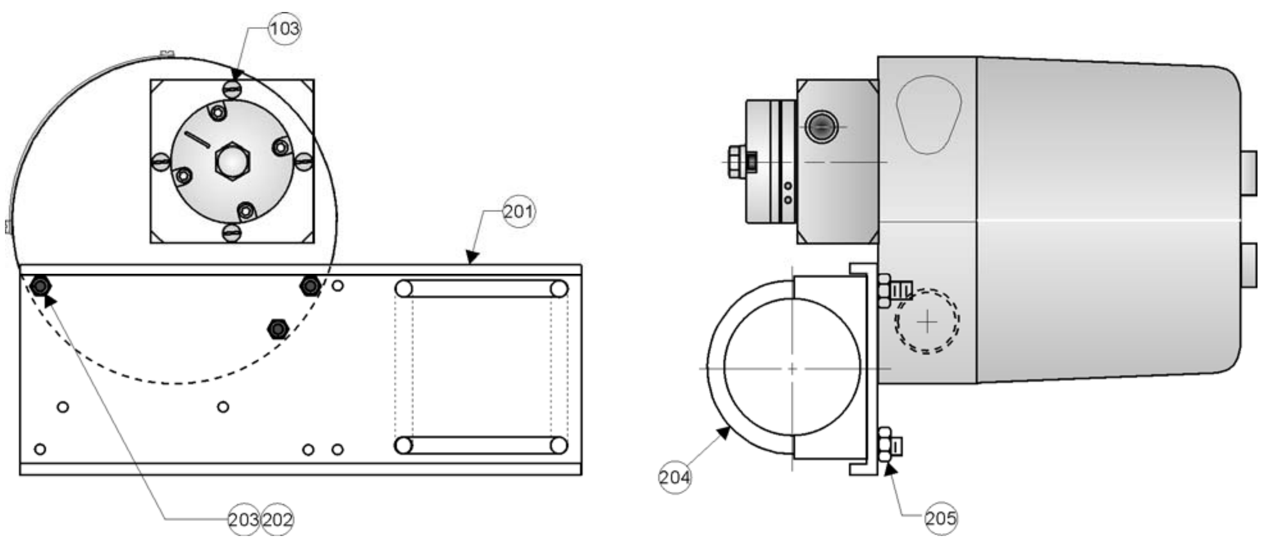


Figure 7-2 – Remote Set Regulator Actuator Unit Mounting Parts

7.2 REMOTE SET REGULATOR BASIC PARTS

Parts Referenced in Figure 7-3

Item	Description	Part Number
103	Diaphragm	383825-01-6
104	Ring, Regulator Exhaust	385389-01-9
105	Base, Pressure Regulator Ass'y.	342172-00-0
106	Spring, Helical Compression	307905-00-4
107	Screw, 10-32 x 1 SHCS	396400-01-9
108	Screw, 7/16 x 20 Pilot Retaining	297261-00-2
110	Plunger, Regulator	307908-00-3
111	Diaphragm, Ass'y. Exhaust	396394-01-9
112	Spacer	297248-00-6
113	Block, Regulator	390570-01-0
116	Diaphragm, Regulator	385268-01-7

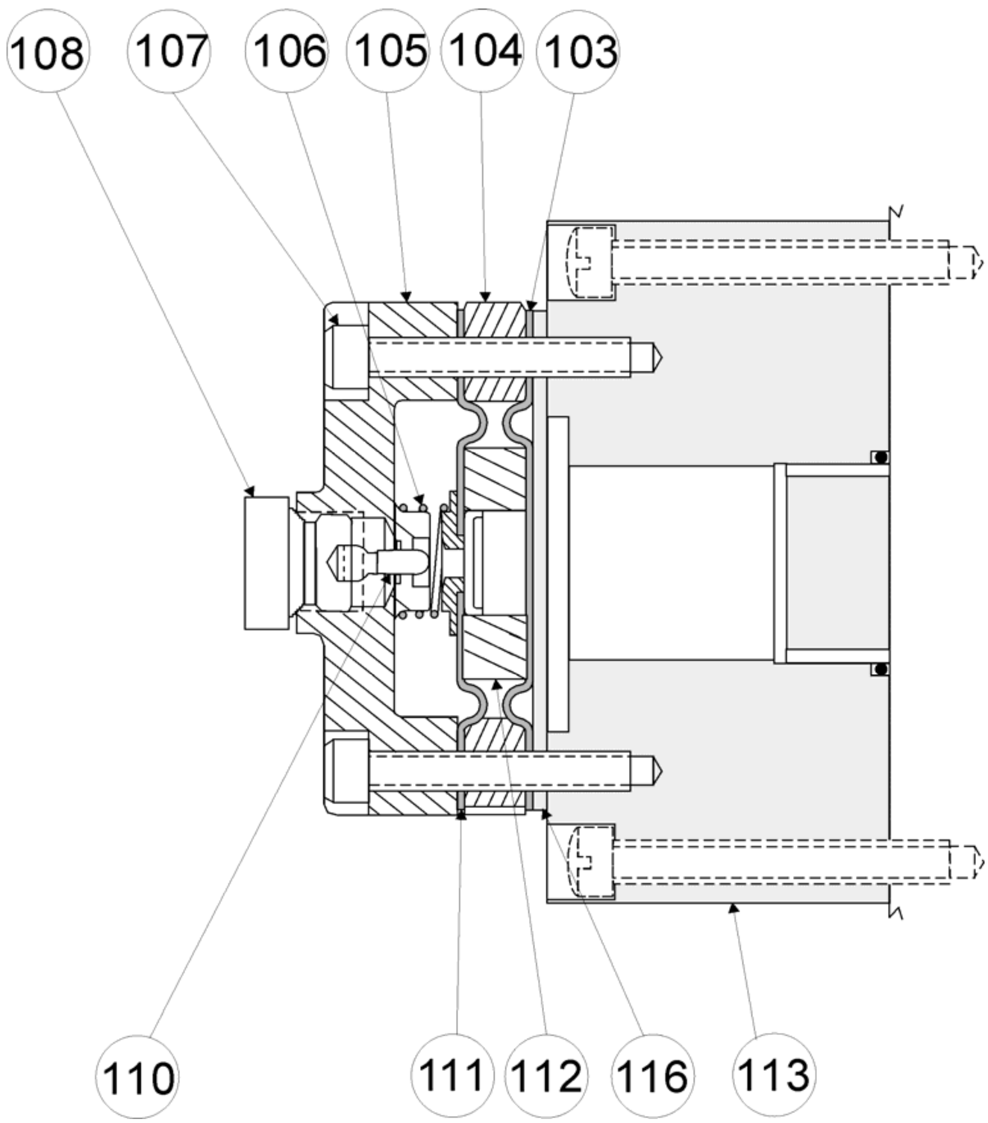


Figure 7-3 – Remote Set Regulator Assembly Basic Parts

Supplement S1400

Guidelines for System Grounding

- Contents -

IMPORTANCE OF GOOD GROUNDS

The equipment used with instrument systems must operate continuously within their stated accuracy over long periods of time with minimum attention. Since many system sites are unmanned and located in remote areas, failures resulting from an improperly grounded system can become costly in terms of lost time. A properly grounded system will help to: prevent electrical shock hazards resulting from contact with live metal surfaces; protect equipment from lightning strikes and power surges; minimize the effects of electrical noise and power transients; and reduce signal errors caused by ground wiring loops. Conversely, an improperly grounded system may exhibit a host of problems that appear to have no relationship to grounding. It is essential that the reader have a good understanding of this subject to prevent needless troubleshooting procedures.

Warning

This device must be installed in accordance with the National Electrical Code (NEC) ANSI/NFPA-70. Installation in hazardous locations must also comply with Article 500 of the code.

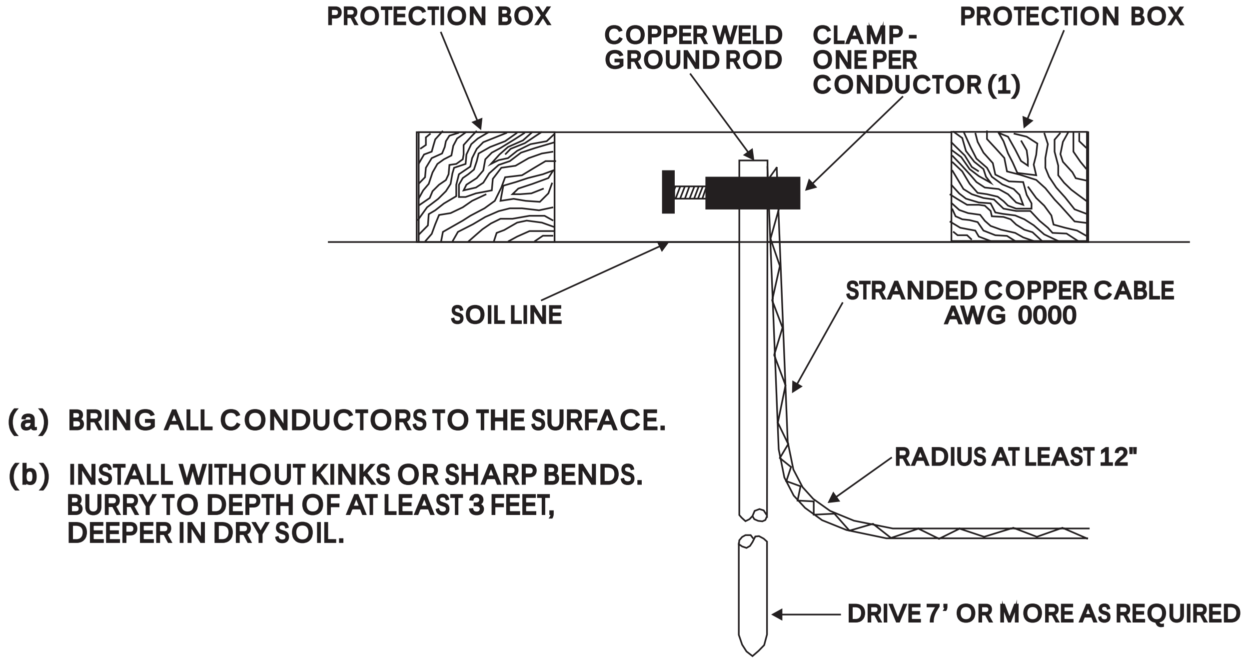


Figure 1 Basic Ground Rod Installation

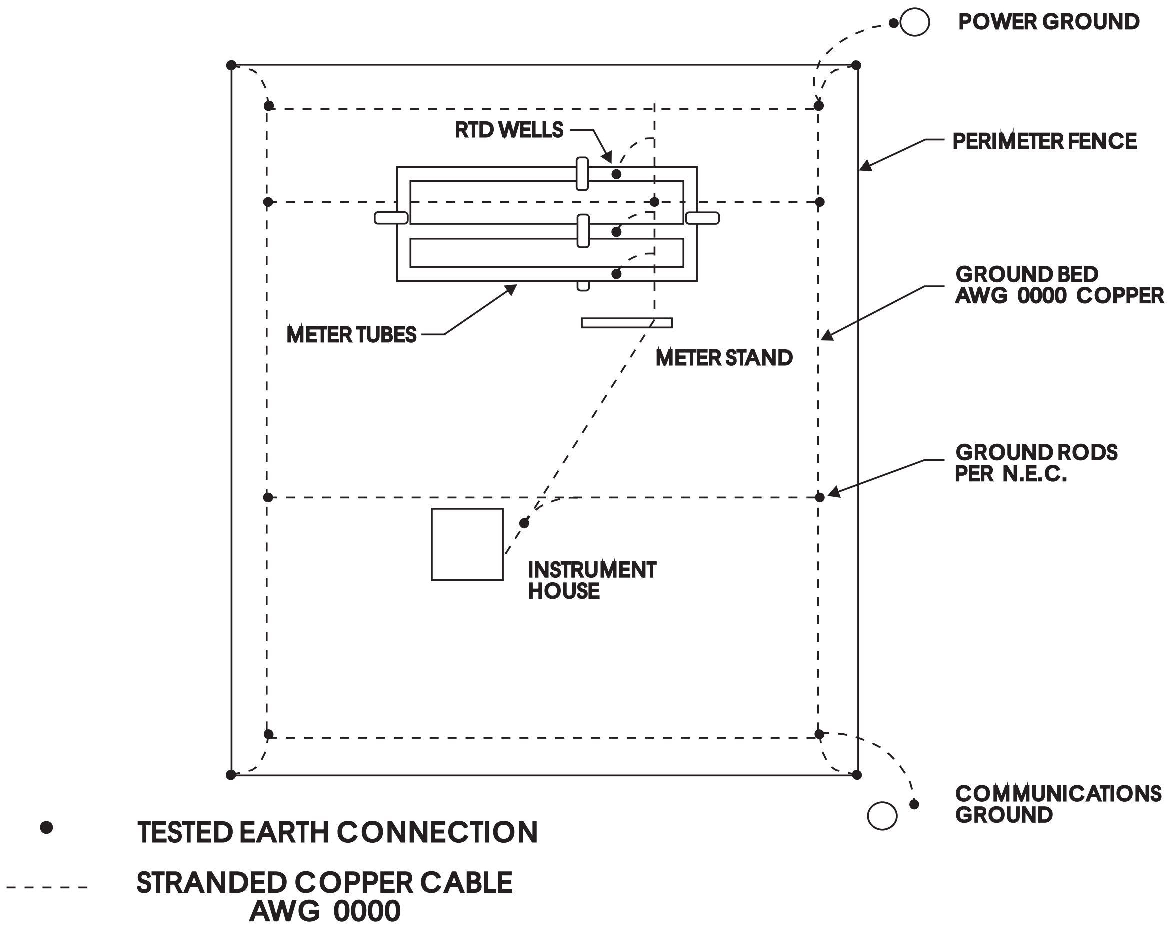


Figure 2 Overhead Map of Ground Bed for Gas Metering Station

GENERAL RECOMMENDATIONS

When wiring equipment into a system, the electrical conduit must have a diameter that will accommodate the desired number of wires. The cross- sectional area of the conduit should be large enough to allow the wires to be pulled through without excessive tightness or binding. A conduit that is too tight can shred insulation, damage wiring, and result in possible opens, shorts, or intermittent effects. Such conditions are often difficult to trace because the defect is concealed inside the conduit.

Noise and Signal Errors

Noise and signal errors are often the result of poor wiring and grounding practices. Some common problem areas are listed as follows:

- *Shielding AIs and AOs.* Very often analog DC signal leads must run parallel to wires radiating AC fields, pulse information, or switching transients. Due to inductive and capacitive pickup, some of this information can leak into an analog I/O and cause peculiar effects in the control systems. To minimize or eliminate this problem, the use of insulated and shielded, twisted lead pairs is recommended between the external devices (transmitters, sensors, etc.) and the instrument inputs (controllers, recorders, etc.).

  The shields of each analog signal source should only be grounded at the input of the instrument. In some equipment, the shield will connect to the instrument chassis. In other equipment, a "shield" terminal will be provided with several grounding options. The user should refer to the instrument manual and follow grounding recom-mendations.

- *Common Returns.* The use of a single "common" return wire for two or more input signals is not recommended. This approach may introduce system ground loops that cause erroneous readings at the instrument. Shielded transmitter or sensor wires should be grounded at the input of the instrument, or connected to a shield terminal (where provided) to prevent "sneak" ground paths.

- *Discrete Outputs.* Instruments provided with bi-state discrete outputs perform functions such as control switching, alarm switching or pulse duration com-munications. These outputs are furnished as either open collector or relay contact outputs that operate at low power levels. While these levels are sufficient to operate many devices, some will require much higher power levels. The use of external amplifiers or repeating relays to drive end devices will prevent output overload and add to the reliability of the system.

- *Compatible System Wiring.* In a distributed system, the designer should use the same wiring identification and color codes throughout to maintain system uniformity. By observing compatibility at all levels, wiring mistakes are minimized and troubleshooting tasks are simplified.

- *Placement of Wiring.* The dressing or physical placement of wiring requires close scrutiny. Cables inside cabinets should be neatly secured at regular intervals. Cables running between cabinets at different locations should be placed in conduits. The cable length should allow sufficient slack for routine operational checks and maintenance of

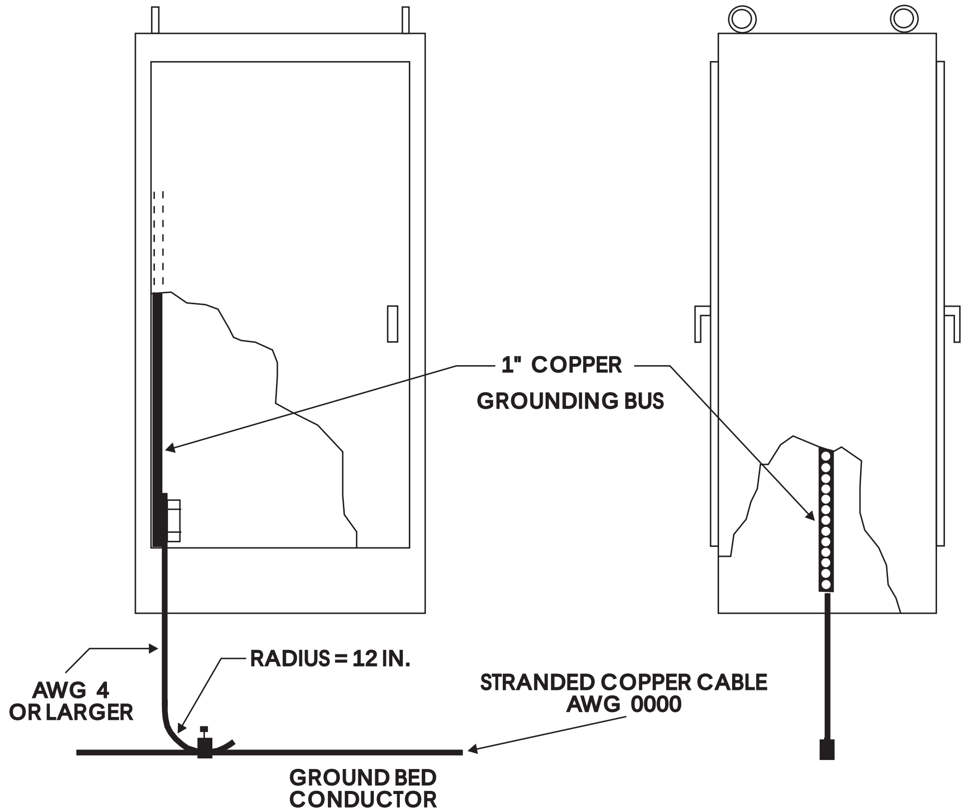


Figure 3 Grounding of Equipment Housing

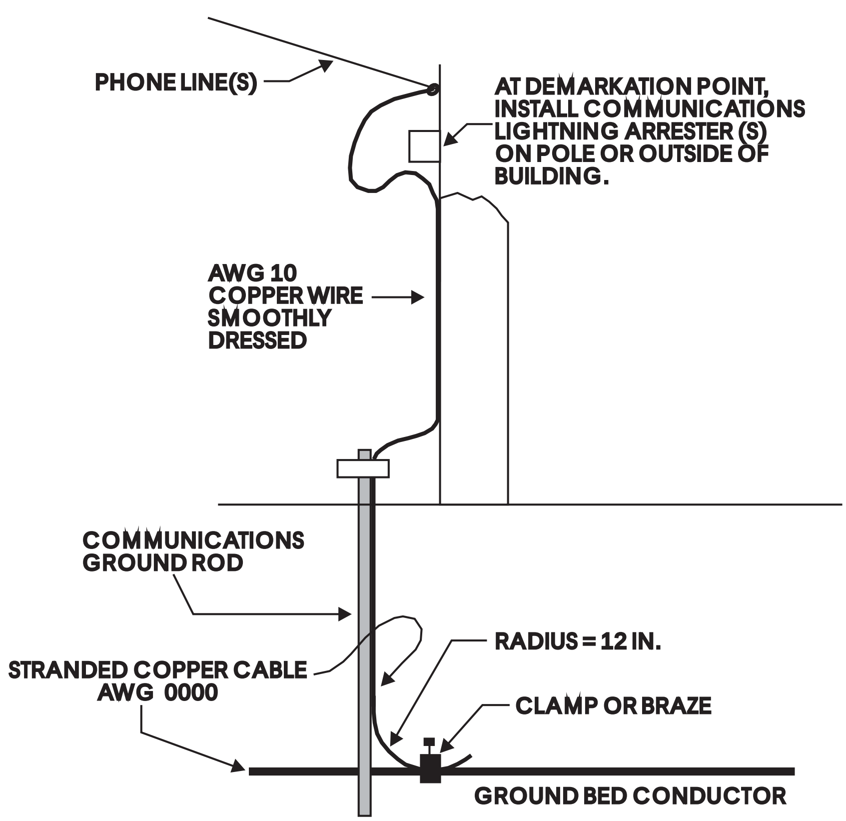


Figure 4 Grounding of Phone Line

the equipment. Wiring from input signal circuits and power circuits should be separated as much as possible to minimize noise and transient pickup. Power and signal leads should be run in separate conduit to minimize inductive pickup.

- *Terminal Lugs.* The use of crimp-type terminal lugs as connections for screw terminals should be avoided. Terminal lugs, in many industrial climates, can be affected by hidden corrosion. It is preferable to tin the wire end with solder and loop it around the terminal screw. The screw should be tightened sufficiently to hold the lead in place but not excessively so that the lead is sheared or the screw is stripped. Equipment furnished with compression-type terminals include an opening for inserting tinned ends.

TRANSIENTS AND INTERFERENCE

The extensive use of low-power integrated circuitry in modern electronic equipment requires proper grounding techniques to insure reliable system operation. The following checklist will help identify some critical areas:

1. All instrumentation devices at the site should be checked so that no potential greater than the standoff voltage can exist within or between devices.

2. To minimize outside signal interference and provide equipment protection from lightning or transients, the earth ground at the site must be tested to insure that its impedance measures less than 10 ohms at 7 MHz. This qualification is essential since a transient potential or an interference signal at the instrument site can vary over the entire electromagnetic spectrum from DC to several hundred MHz.

   Note that transients can be produced through natural phenomena and man-made conditions. Natural transients may result from lightning (7-14 MHz), static (many frequencies), and wind (DC charge and static). Man-made transients can result from defective light bulbs or electrical appliances, sudden electrical load shifts, inductive load surges, arcing contacts and poor AC power connections.

3. If radio frequency (RF) interference is present at the input of an instrument, observe if it has a consistent or irregular pattern. Constant interference can come from commercial radio stations, while irregular interference can come from private stations. Although shielding and grounding will eliminate or minimize most cases of RF interference, obstinate cases may require attenuation filters.

   RF interference can also be caused by power companies that apply modulated RF signals to power lines to communicate data. Other RF noise sources include digital clocks, computers, relay contacts, motors transformers, switches, arc welders, etc.

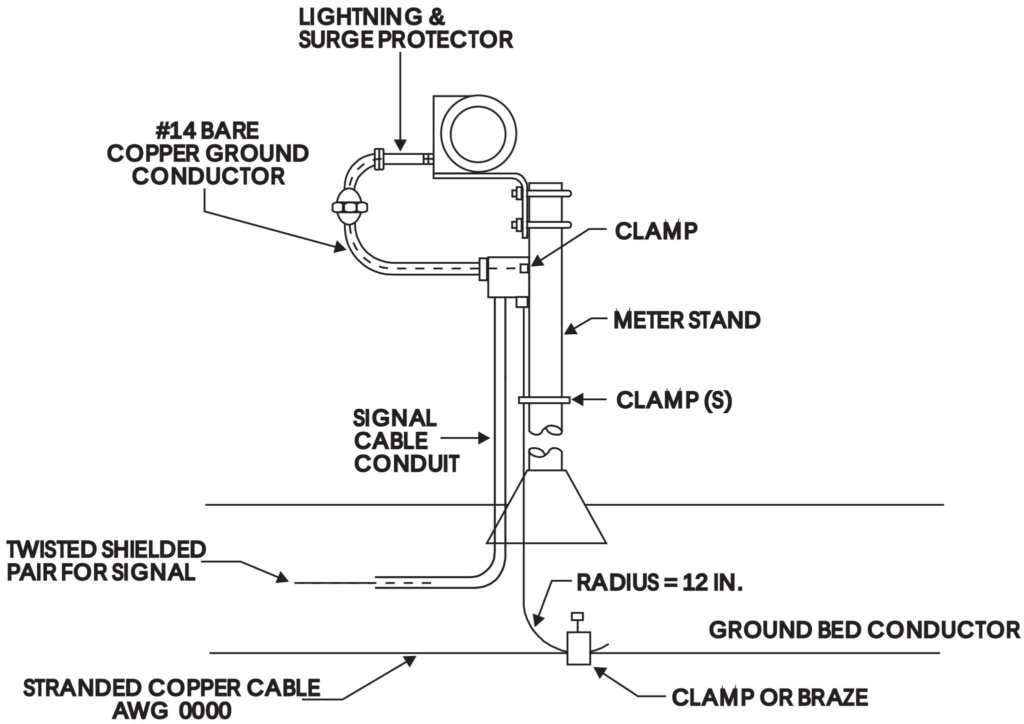


Figure 5 Grounding of Transmitter

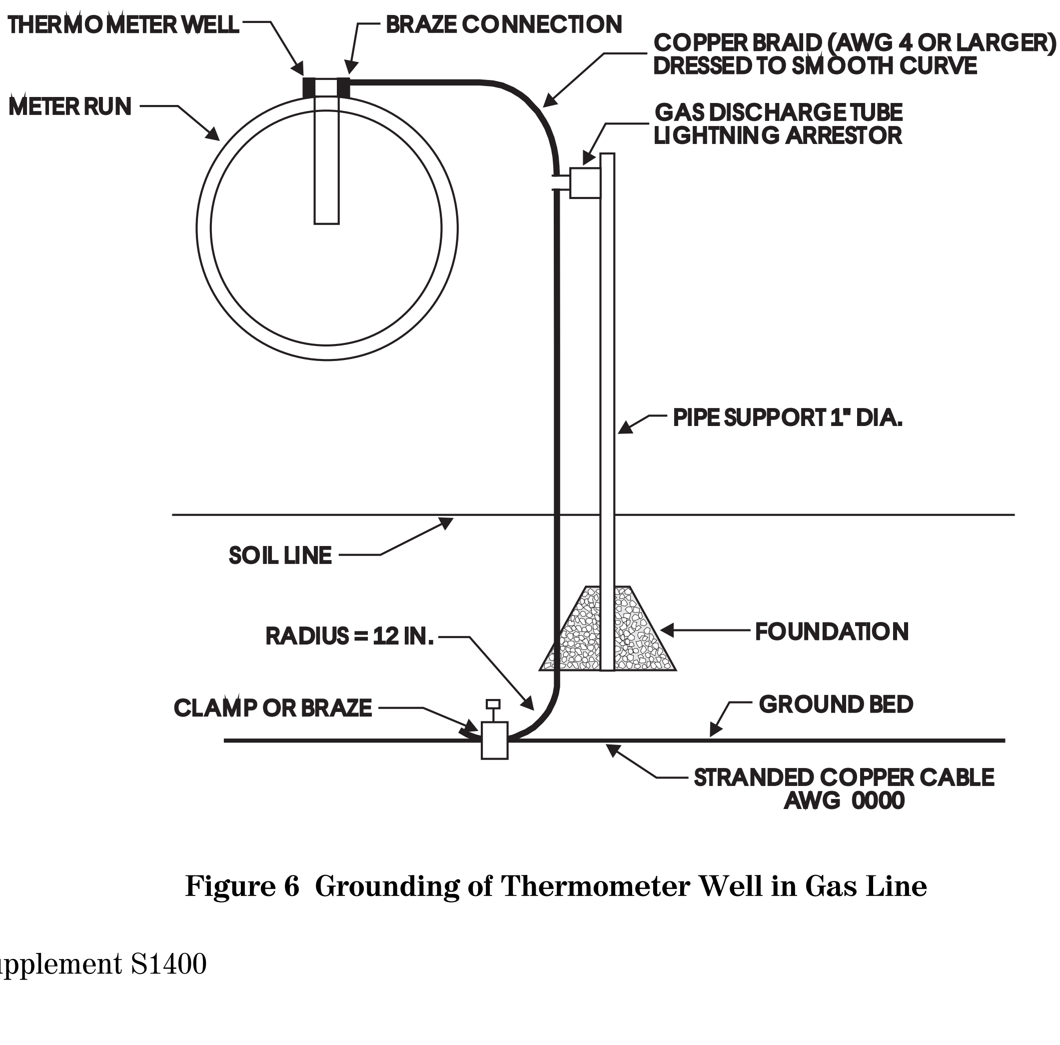


Figure 6 Grounding of Thermometer Well in Gas Line

TYPES OF EARTH GROUNDS

A common misconception of a ground is that it consists of nothing more than a metal pipe driven into the soil. While such a ground may function for some applications, it will often not be suitable for a complex system of sophisticated electronic equipment. Conditions such as soil type, composition and moisture will all have a bearing on ground reliability.

A basic ground consists of a rod 3/8 in. diameter with a minimum 8 ft. length driven into conductive earth to a depth of about 7 ft as shown in Figure 1. Number 14 AWG solid copper wire (or larger) should be used for the ground wire. The end of the wire should be clean, free of any coating, and fastened to the rod with a clamp. A cover or housing should be installed over the ground connection to protect it from the weather and the environment.

Where soil conditions are poor, additional ground rods can be driven into the earth at various distances and strapped together. Figure 2 shows an overhead layout of a ground bed used for a gas metering station. Other arrangements (not shown) consist of a buried wire counterpoise or a 3 ft. square copper plate.

A ground should be tested for conductivity before putting it into service. Details on on this test are described in the NATIONAL ELECTRIC CODE HANDBOOK. Once a reliable ground has been established, it should be tested on a regular basis to preserve system integrity.

Instrument enclosures, measuring devices, metal process vats, metal piping, and other associated mechanical and electrical devices should all be grounded. The method of grounding an instrument rack is shown in Figure 3. In this application the ground lead typically attaches to a ground bus that is common to all equipment in the rack.

For applications employing equipment that communicates over telephone lines, a lightning arrestor must be provided at the point where the communication line enters the building as shown in Figure 4. The ground terminal of this arrestor must connect to a ground rod and/or a buried ground bed.

Applications that use transmitters or transducers require grounding and shielding. In Figure 5, the ground conductor feeds through the electrical conduit and connects to the ground screw of the transmitter even though the support pipe is grounded. However, if the transmitter uses shielded wiring for its signal output, the shield should not be grounded at the transmitter. For maximum signal accuracy, the shield should only be grounded at one point in the system, typically at the input of the associated equipment.

Gas lines also require special grounding considerations. If a gas meter run includes a thermocouple or RTD sensor installed in a thermometer well, the well (not the sensor) must connect to a gas discharge-type lightning arrestor as shown in Figure 6. A copper braid, brazed to the thermal well, is dressed into a smooth curve and connected to the arrestor as shown. The curve is necessary to minimize arcing caused by lightning strikes or high static surges. The path from the lightning arrestor to the ground bed should also be smooth and free from sharp bends for the same reason.

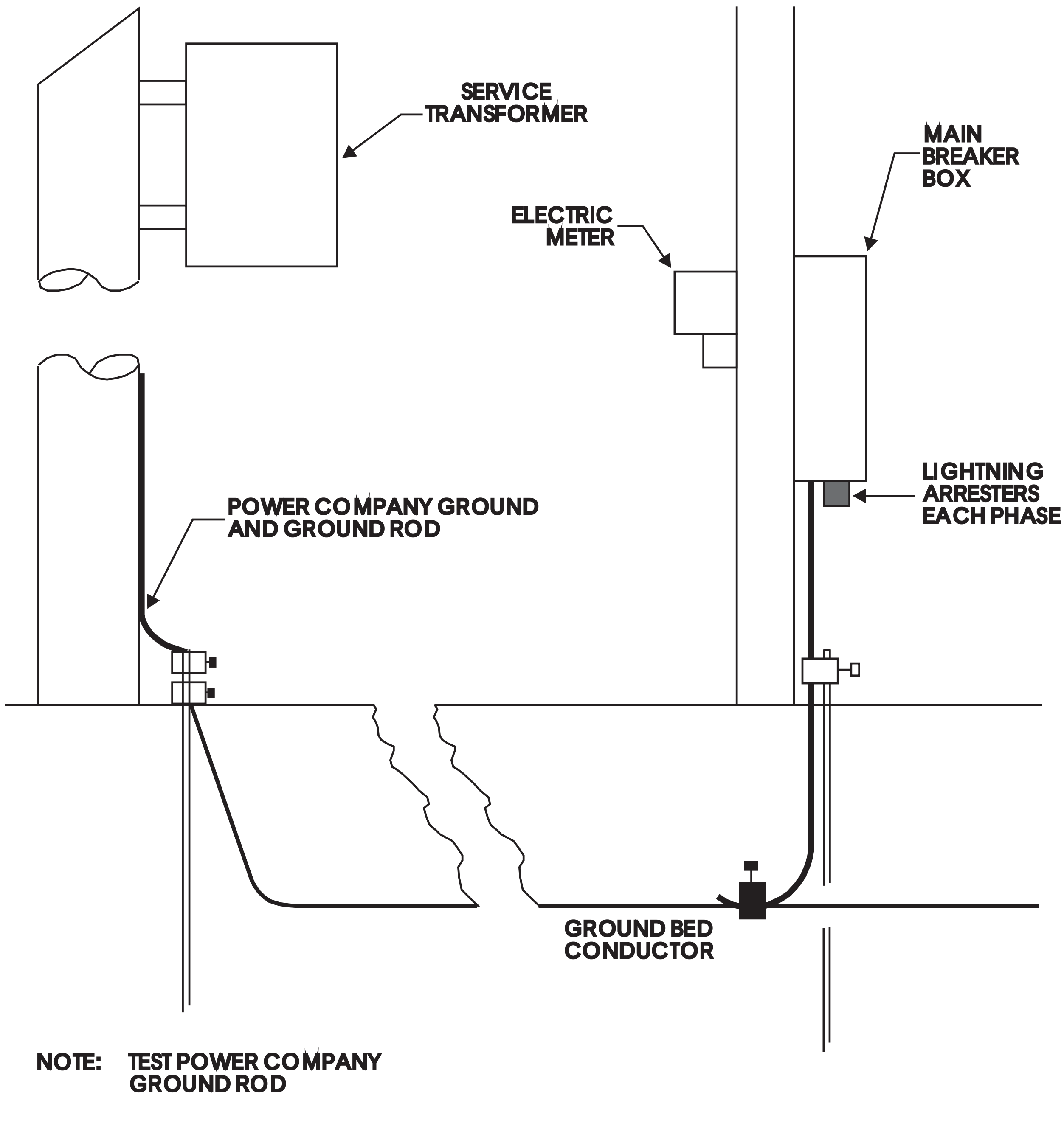


Figure 7 AC Power Grounding System

The ac power required to operate a system typically includes a service transformer located at the street and a main breaker box and rate meter assembly at the building as shown in Figure 7. The service transformer is grounded at the company's pole, while the breaker box is grounded at the building. A lightning arrestor should be included at the breaker box in each phase of the AC line, and each arrestor should be grounded accordingly.

SOIL CONDITIONS

Before installing a ground rod, the soil type and moisture content should be analyzed. Ideally, the soil should be moist and moderately packed throughout to the depth of the ground rod. However, some soils will exhibit less than ideal conditions and will require extra attention.

Dry Soil

Very dry soil will not provide enough free ions for good conductance and a single ground rod will not be effective. A buried counterpoise or copper screen is recommended for these situations. It will also be necessary to keep the soil moist through regular applications of water.

Sandy Soil

Sandy soil, either wet or dry, may have had its soluble salts leached out by rain water, thereby reducing conductivity of the ground. High currents from lightning strikes could also melt sand and cause glass to form around the ground rod, making it ineffective. A buried counter- poise or copper screen is preferred for these installations along with regular applications of salt water.

Rocky Soil

Rocky soil can pose many grounding problems. A counterpoise or copper plate will probably be required. Constructing a trench at the grounding site and mixing the fill with a hygroscopic salt such as calcium chloride may help for a time. Soaking the trench with water on a regular basis will maintain conductivity.

GROUNDING TECHNIQUES FOR SERIES 33XX SYSTEMS

When installing a system that includes a number of Bristol Babcock, Series 33XX Distributed Process Controllers (DPCs), it is essential to follow the procedures set forth by the National Electrical Code (NEC) to minimize risk of equipment damage and electrical shock.

WARNING

Electrically powered equipment must be properly grounded to protect users from electrical shock and injury. All such devices must be installed, wired, and grounded in accordance with the National Electrical Code (NEC).

Series 33XX DPCs employ a power grid ground terminal (CHASSIS) and an instrument ground terminal (24VRET) that connects to the "zero reference point" of the system. Improper grounding of these terminals can produce multiple ground paths throughout the system and result in increased noise pickup and signal offset errors. If more information is required on this subject, the reader should refer to the publications cited at the end of this document.

The examples that follow describe the grounding techniques for several types of Bristol Babcock systems employing DPCs. Refer to the system description that is closest to your application.

Several DPCs Mounted in Metal Cabinet with Power Supply

A small system can consist of one or more DPCs mounted in a single metal cabinet or rack with a power supply. A power wiring diagram for this arrangement is shown in the example of Figure 8. The following installation procedures apply:

1. Instrument Ground. The instrument ground of the DPCs (24VRET terminal of each DPC) must connect to a terminal block within the cabinet that is electrically isolated from the cabinet frame. This terminal block must provide termination for all in-strument grounds and include termination for a multistranded, insulated, #4 gauge wire (or greater). This wire, which will connect to the "zero reference point" of the facility, must be run through metal conduit (pipe). Only the #4 wire will be contained in this conduit. The conduit must also be connected by bonding strap to the cabinet and facility frame as described in the NEC.

2. Setting DPC Power Jumpers. If the DPC is a Model 3335 OR 3310, jumpers W1A and W1B on the System Interconnect Board must be removed to isolate the chassis connection from the 24VRET connection (see Figure 8). If it is a Model 3330, jumpers W1A, W1B and W1C on the System Interconnect Board must be removed. Series 3308 Gas Flow Computers or Correctors, if used with these systems, provide an isolated instrument ground without setting jumpers.

3. AC Power Source. The 24 Vdc power supply requires a 120 Vac power source. The ac power terminals of this supply are identified in Figure 8. The 120 Vac wiring for this supply must be contained in cable trays along with the power grid grounding wire. Figure 9 illustrates the cable tray layout and grounding points of a typical facility. The cabinet frame and the DPC chassis must be connected with bonding strap at points specified in the NEC.

4. Grounding of Peripheral Equipment. Some peripheral devices such as printers, CRTs, personal computers, etc., have their internal logic ground connected to the chassis. This configuration will cause loss of isolation between the DPC's instrument ground and chassis. These devices may still be used providing that opto- isolated circuits, galvanic isolation, or other types of circuitry between the device and the DPC are added to maintain the integrity of the DPC's instrument ground-to-chassis isolation.

Multiple DPC Cabinets with Local Power Supply in Each Cabinet

This application consists of two or more DPC cabinets either separated or clustered together in a room. Each cabinet has its own 24 Vdc power supply. The following procedures apply:

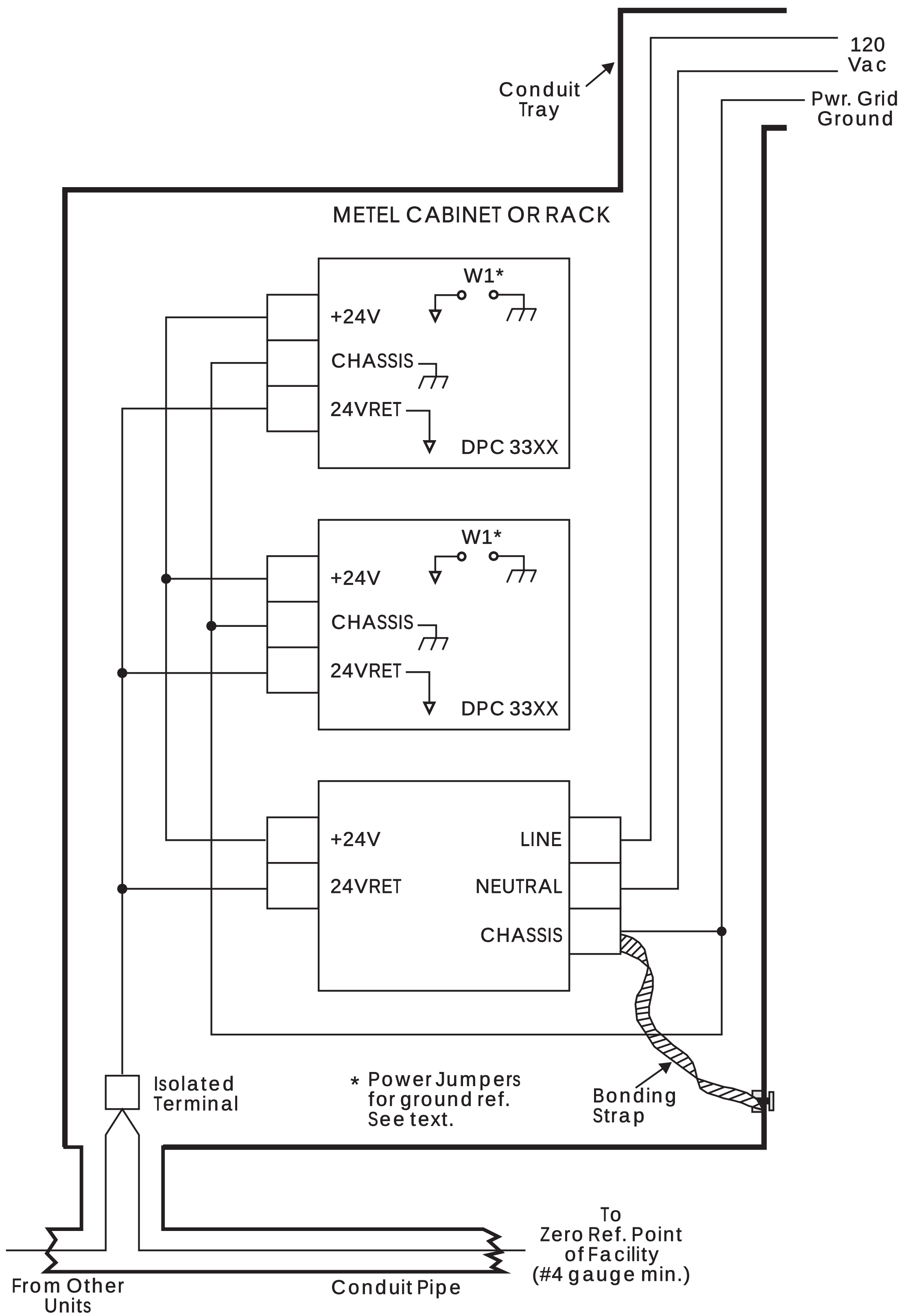


Figure 8 Grounding for DPCs and Power Supplies in Single Metal Cabinet

1. Multi-Cabinet Instrument Grounding using Multiple Supplies. The instrument ground (24VRET terminal) of each DPC in a cabinet must connect to a terminal block within that cabinet that is electrically isolated from the cabinet frame. This terminal block must provide termination for all DPC instrument grounds within that cabinet and include termination for a #4 gauge (or greater), multistranded, insulated wire that will connect to the zero reference point of the facility. This #4 wire will be run through metal conduit (pipe) to the same termination point in the other cabinets. Only the #4 wire will be containe in this conduit. This conduit must also be connected by bonding strap to the cabinet and facility frame as described in the NEC.

2. Setting DPC Power Jumpers. If the DPC is a Model 3335 or 3310, jumpers W1A and W1B on the System Interconnect Board must be removed to isolate the chassis connection from the 24V RET connection (see Figure 8). If it is a Model 3330, jumpers W1A, W1B and W1C on the System Interconnect Board must be removed. Series 3308 Gas Flow Computers, if used with these systems, provide an isolated instrument ground without setting jumpers.

3. AC Power Source. The 24 Vdc power supply requires a 120 Vac power source. The ac power terminals of this supply are identified in Figure 8. The 120 Vac wiring for this supply must be contained in cable trays along with the power grid grounding wire. Figure 9 illustrates the cable tray layout and grounding points of a typical facility. The cabinet frame and the DPC chassis must be connected with bonding strap at points specified in the NEC.

4. Grounding of Peripheral Equipment. Some peripheral devices such as printers, CRTs, personal computers, etc., have their internal logic ground connected to the chassis. This configuration will cause loss of isolation between the DPC's instrument ground and chassis. These devices may still be used providing that opto-isolated circuits, galvanic isolation, or other types of circuitry between the device and the DPC are added to maintain the integrity of the DPC's "instrument ground to chassis" isolation.

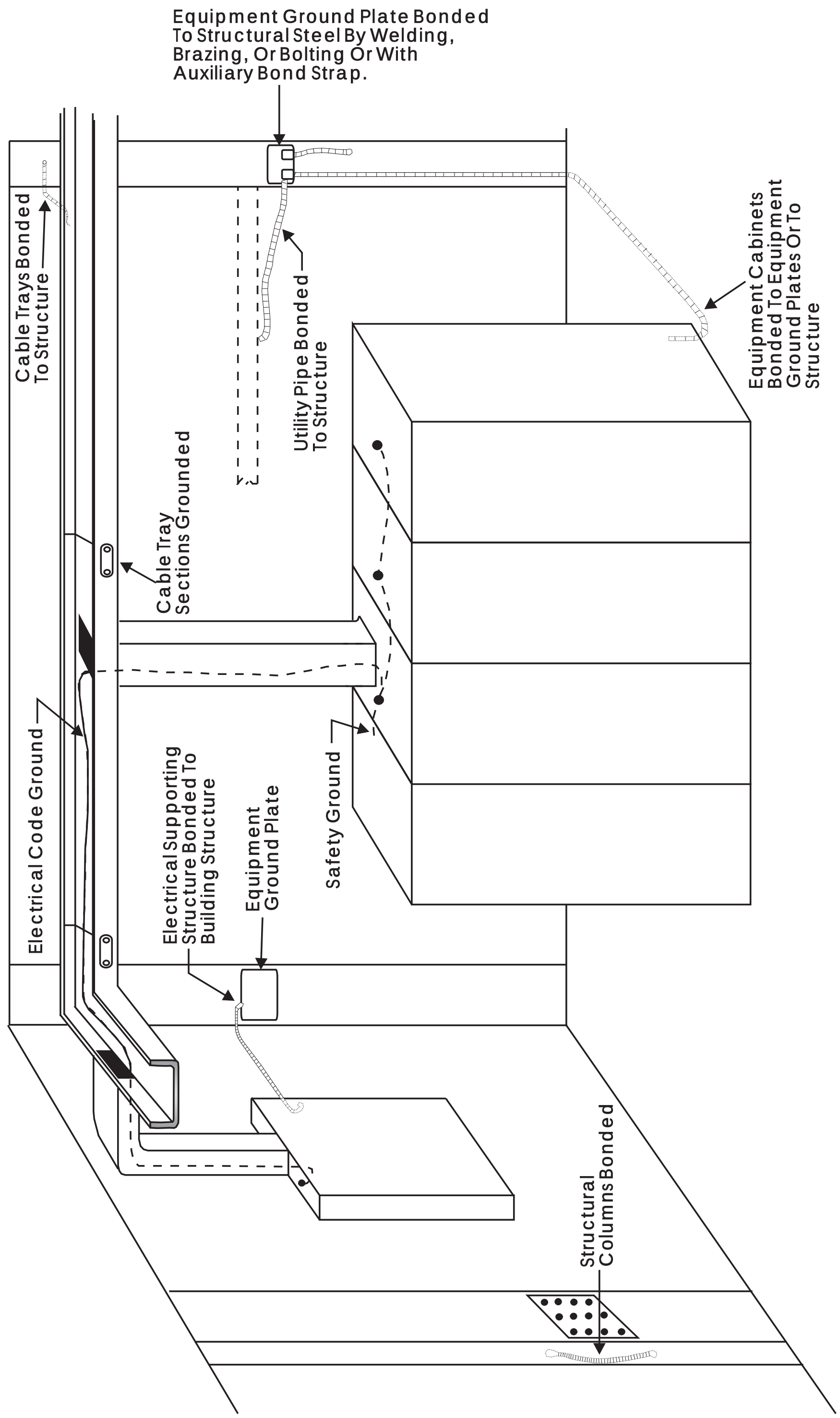
Multiple DPC Cabinets Powered by Single Power Supply

All of the DPC cabinets in this installation operate from a single power supply which may be installed in one of the cabinets or in a separate cabinet. The following procedures apply:

1. Multi-Cabinet Instrument Grounding using Single Supply. The instrument ground (24VRET terminal) of each DPC in a cabinet must connect to a terminal block within that cabinet that is electrically isolated from the cabinet frame. This terminal block must provide termination for all instrument grounds within that cabinet and include termination for a multistranded, insulated, #4 gauge wire (or greater).

2. Routing of Instrument Ground and 24 V Power Wires. The #4 wire, along with +24V and 24VRET wires, are run through conduit trays to the power supply. The #4 wire connects to the 24VRET terminal of the supply and to the zero reference point of the facility. The +24V and 24RET wires connect to corresponding terminals on the power supply.

3. Cable Trays. Figure 9 illustrates the cable tray layout and grounding points of a typical facility. The cabinet frame and the DPC chassis must be connected with bonding strap at points specified in the NEC. The NEC also applies to the connection of the 120 Vac power supply terminals to the line.



From: Grounding for the Control of EMI by Hugh W. Denny (see ref. 1)
- Courtesy of Interference Control Technologies -

Figure 9 Elements of a Facility Ground System

4. Setting DPC Power Jumpers. If the DPC is a Model 3335 or 3310, jumpers W1A and W1B on the System Interconnect Board must be removed to isolate the chassis connection from the 24V RET connection (see Figure 8). If it is a Model 3330, jumpers W1A, W1B and W1C on the System Interconnect Board must be removed. Series 3308 Gas Flow Computers, if used with these systems, provide an isolated instrument ground without setting jumpers.

Multiple Clusters of DPC Cabinets Powered by Local Supplies

A cluster consists of two or more DPC cabinets that may be grouped together as shown in Figure 9. Several such clusters performing related functions in the same facility make up a multiple cluster system. The following procedures apply:

1. Grounding for DPC Cabinet Cluster using Local Supply. The instrument ground (24VRET terminal) of each DPC in a cabinet must connect to a terminal block within that cabinet that is electrically isolated from the cabinet frame. This terminal block must provide termination for all instrument grounds within that cabinet and include termination for a multistranded, insulated, #4 gauge wire (or greater) that will connect to the same termination point to other cabinets of that cluster, and to the 24VRET terminal of the local power supply.

2. Routing of Cluster Grounds. The instrument grounds (isolated terminal) from each cabinet cluster must connect to each other and then to a single wire that connects to the zero reference point of the facility. This wire should be #4 gauge minimum (multistranded and insulated) and be contained in a metal conduit (pipe). A heavier stranded #4/0 gauge could be used to connect each cluster to the zero reference point while the #4 wire instrument grounds could be locally terminated to the #4/0 wire. The conduit containing this wire must also be connected by bonding strap to the cabinet and facility frame as described in the NEC.

3. AC Power Source. The 24 Vdc power supply of each cluster requires a 120 Vac power source. The ac power terminals of this supply are identified in Figure 8. The 120 Vac wiring for this supply must be contained in cable trays along with the power grid grounding wire. Figure 9 illustrates the cable tray layout and grounding points of a typical facility. The frame of each cabinet and each DPC chassis a cluster must be connected with bonding strap at points specified in the NEC.

4. Setting DPC Power Jumpers. If the DPC is a Model 3335 or 3310, jumpers W1A and W1B on the System Interconnect Board must be removed to isolate the chassis connection from the 24V RET connection (see Figure 8). If it is a Model 3330, jumpers W1A, W1B and W1C on the System Interconnect Board must be removed. Series 3308 Gas Flow Computers and Correctors, if used with these systems, provide an isolated instrument ground without setting jumpers.

References:

1. Grounding for the Control of EMI; Hugh W. Denny;
   Don White Consultants, Inc. (c) 1983, 1st Ed.
2. IEEE Std. 518-1982
3. ANSI/IEEE Std. 142-1982

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